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The Seneb´s Enigma: Impact of a hybrid personal and social responsibility and gamification model-based practice on motivation and healthy habits in Physical Education.

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Abstract: Increasing physical activity (PA) and personal and social values are two of the greatest demands in the current educational system. This study examined the effect of a hybrid programme based on the Personal and Social Responsibility Model and Gamification. A total of 58 students (13.89 years old, SD = 1.14) in two groups (Experimental and Control) participated during a complete academic year. Motivation, physical activity and sedentary behaviour were assessed though questionnaires. Physical fitness was evaluated using previously validated field tests. The results showed significant differences over time between EG and CG in afterschool physical activity (APA) at the weekend (p = 0.003), sedentary time (p = 0.04) and speed-agility (p = 0.04). There were no significant differences in motivation. Regarding the intervention, speed-agility (p = 0.000), strength (p = 0.000), agility (p = 0.000), cardiorespiratory fitness (p = 0.001), APA-weekend (p = 0.000), APA-week (p= 0.000) and sedentary time (p = 0.000) increased significantly in the EG. Speed-agility (p = 0.000), APA-weekend (p = 0.03) and sedentary time (p = 0.008) increased in the CG. The use of this hybrid program can be useful to produced improvements in physical fitness, physical activity and sedentary hevaviours.

Keywords: physical fitness; physical activity; sedentary time; self-determination theory; afterschool period.

1. Introduction

Increasing physical activity (PA), and thus physical fitness (PF) levels, among adolescents continues to be a world priority due to the positive physical and mental health benefits associated with maintaining an active lifestyle [1]. Experts stress that PA habits

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need to be developed early in life [2] and highlight that positive and early PA experiences increase PA likelihood [3] and reduce sedentary behaviour and many risk factors linked to cardiovascular disease [4,5].

Educational centres have been identified as the main places for promoting PA and health, especially during physical education (PE) classes [2,6] and afterschool periods [7,8]. It is important to determine whether children perceive PE as a valuable, enjoyable and rewarding experience or as a worthless, boring and humiliating one [9].

A recent study highlighted that motivation is the leading theme within the field of sport and exercise psychology across different contexts, including sport, exercise, health psychology and school PE [10]. Motivation is crucial to engaging students in activities from which they can benefit physiologically and psychologically [11]. The self-determination theory (SDT) approach to motivation can be particularly helpful in this sense, as it shows the important role of different motivational types on cognitive, behavioural and affective outcomes [12,13].

Gamification techniques or the art of employing games in the classroom [14] are a complement to increase extrinsic motivation. Although games provide freedom in learning, where failure allows learning without fear, thus increasing student engagement [15], the use of games is being questioned [16-19]. In a review study, Hamari, Koivisto and Sarsa (2014) [17], concluded that gamification studies are limited by methodological problems such as small sample sizes, a lack of comparison groups (gamified and non-gamified experiences), short treatments, singular assessments or a lack of validated measures. Additionally, Koivisto and Hamari [20] showed that the appeal of a gamified system might be due to a novelty effect, which could yield decreasing engagement and interest over time. Many gamification elements, particularly the use of badge and reward systems [21-23], leader boards and social comparison [24] or competition [25-27] might have detrimental effects over the long term for student's motivation, satisfaction, enjoyment and engagement, although they are usually used in gamified experiences [28].

Such strategies are thus emerging as an ideal foundation on which to build the teaching of PE. Accordingly, the scientific field has investigated the best way to acquire and develop educational content using different pedagogical models [29], also known as models-based practice (MsBP) [30]. MsBP focus on the reachable goal of helping practitioners implement methods in a contextualized and confident way [31], modifying the peculiarities of instructional models [32]. For instance, teaching for personal and social responsibility (TPSR) [33] is an MsBP focused on facilitating life skills through several educational tools and strategies.

However, several authors believe in the power of MsBP hybridization beyond the combination of educational elements [34,35] and have emphasized that isolated MsBPs present limitations when implemented because each model is mainly focused on a specific content area [34]. Such models can also help educators innovate to fit current educational frameworks and fully reach all their students [36], knowing that combined benefits in the physical/motor, cognitive, affective and social domains only occur when merging different pedagogical models [35,37].

Many studies in the scientific literature have adopted SDT strategies in PE interventions [38-46], but only two have been hybridized with another pedagogical model [43,45]. This suggests the need for further research on the hybridization of pedagogical models within any of the elements of the self-determination continuum in a large PE intervention, comparing an experimental and control group and with a proper and validated measurements.

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The present study therefore examined the influence of a hybrid TPSR and gamification PE intervention within the framework of the SDT on motivation, physical fitness, PA and sedentary time.

2. Materials and Methods

2.1. Study Design

A group-randomized controlled trial [47] was carried out from September 2018 to June 2019. The intervention programme lasted for 9 months in two secondary schools assigned to the control group (CG) or experimental group (EG). Sociodemographic and cultural characteristics were similar. Participants aged between 13 and 15 years had to be enrolled in the second or third year of compulsory secondary education at the beginning of the intervention in one of the two secondary schools selected. The contents were selected according to the current education laws [48]. Before and after the intervention, the students were required to carry out the tests in two different sessions. Informed consent (participation in the study, confidential data treatment and session recording) was requested from the students and their parents. *2.2. Exclusion criteria and participants*

Participation was proposed to all students enrolled in one of the courses. Exclusion criteria were that participants did not have any partial or chronic injury or disease that would prevent them from performing any of the physical and cognitive tests, participating normally in PE lessons, nor been diagnosed as a student with specific needs for educational support. Initially, 72 adolescents began the intervention (Figure 1), with 69 (age: 13.92 ± 1.09 years) who completed the experience (37 boys and 32 girls) allocated to the CG (n = 39) and EG (n = 30).

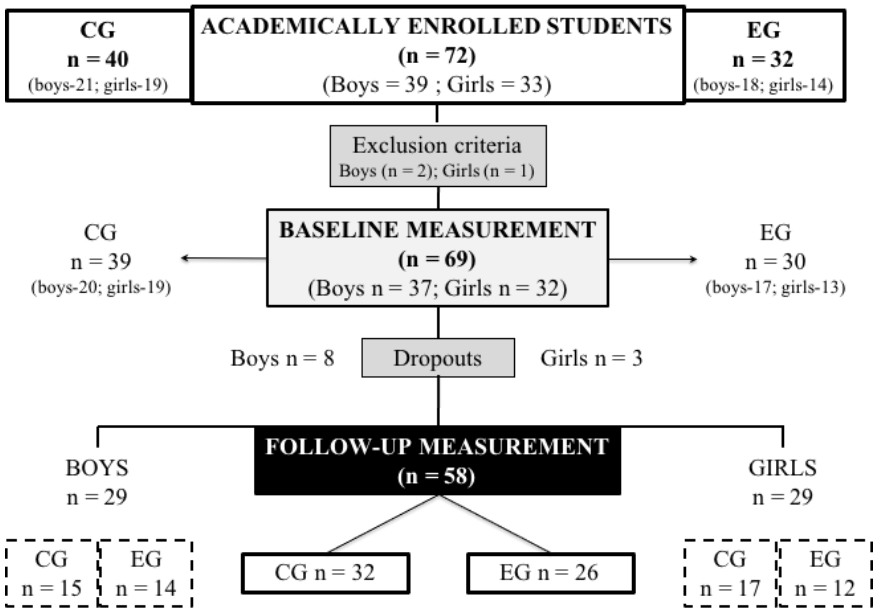

Figure 1. The flowchart of the participants

A total of 58 participants completed the study, or 80.55% of the total number of students who started it, 32 in the CG and 26 in the EG. For the 11 students who did not finish the study, seven from the CG (5 boys and 2 girl) and 4 from the EG (3 boys and 1 girls), left the study due to school absenteeism, missing more than 20% of PE lessons (n = 2), errors or lack of response to any question in the questionnaire (n = 5) and discomfort during the performance of any of the physical or cognitive tests in the post-test (n = 4).

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Each group (CG and EG) received two PE lessons per week, each lasting 55 minutes. Whereas the EG participated in a PE programme based fundamentally on the hybridization of TPSR and gamification strategies, taking into account game-based learning, the CG used traditional learning methods characterized by non-integration and lack of transfer of learning outside of school. The teacher of the CG had no experience in active methodologies like those mentioned above.

2.3. Instruments

Physical Fitness. The PF assessment protocol was used in the previously published European HELENA study (Healthy Lifestyle in Europe by Nutrition in Adolescence: www.helenastudy.com) [50-52]. The PF tests used have shown optimal validity and reliability in application in the adolescent population [53-55]. Cardiorespiratory fitness was assessed by the 20-metre shuttle run test; speed and agility were evaluated by the 4 × 10 metre speed-agility test; and lower body strength was measured by the standing broad jump. Additionally, the hexagon test was used to evaluate agility-coordination and dynamic balance [56].

Lifestyle habits. The Youth Activity Profile-Spain (YAP-S) questionnaire (α = 0.672 and 0,641; pre and post-test) was used to analyze the time spent practicing PA (in school and afterschool) and sedentary activities, such as watching television, playing video games or using mobile phones. The reliability of each one, pre and post-test was: PA in school (α = 0.529 and 0.595), afterschool physical activity (APA) weekday (α = 0.705 and 0.755), APA-weekend (α = 0.829 and 0.710), APA-week (α = 0.790 and 0.733) and sedentary time (α = 0.522 and 0.394). Moreover, it was for the whole sample who finished the intervention. It has previously been validated [57] and used in more intervention studies [58,59].

Table 1 shows the characteristics of the adolescents who started and finished as well as the variables.

Table 1. Initial data of the participants and variables.

	Participants (n=58)		**EG (n=26)**		**CG (n=32)**		*p*
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**	
Boys %	50%		53.84%		46.87%		
Girls %	50%		46.16%		53.13%		
Age (years)	13.89	1.14	14.57	1.36	13.34	0.48	
Amotivation	2.38	1.52	3.29	1.63	1.64	0.92	0.001**
IM to know	4.84	1.23	4.48	1.15	5.14	1.22	0.056
IM to accomplish things	4.94	1.40	4.63	1.07	5.19	1.59	0.214
IM to experience stimulation	4.06	1.38	4.00	1.40	4.12	1.37	0.442
IM general average	4.61	1.22	4.37	1.09	4.82	1.30	0.163
EM external regulation	5.87	1.05	5.53	1.05	6.15	0.98	0.050
EM introjected regulation	4.92	1.26	4.89	1.08	4.94	1.41	0.583
EM identified regulation	5.51	1.27	4.92	1.05	6.00	1.24	0.002**
PA in school	2.90	0.83	2.97	0.92	2.85	0.75	0.844
APA (weekday)	2.95	0.86	2.70	0.84	3.16	0.82	0.276
APA (weekend)	2.60	1.00	2.13	0.91	2.98	0.92	0.005**
APA (week)	2.81	0.79	2.47	0.77	3.09	0.70	0.033*
ST	2.66	0.57	2.93	0.57	2.44	0.47	0.003**
SPD-AGI	13.01	1.16	13.30	1.13	12.77	1.14	0.185
Strength	1.56	0.35	1.54	0.37	1.57	0.33	0.835
Agility	14.49	2.41	15.42	2.35	13.74	2.22	0.036*

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CF	4.59	2.21	3.86	2.08	5.18	2.17	0.157

Note: SE: standard error; EG: experimental group; CG: control group; IM: intrinsic motivation; EM: extrinsic motivation; PA: physical activity; APA: afterschool physical activity ST: sedentary time; SPD-AGI: speed/agility; CF: cardiovascular fitness

2.3. *Fidelity of the implementation*

Hastie and Casey [60] have indicated that researchers should provide: "(a) a rich description of the curricular elements of the teaching unit, (b) detailed validation of program implementation based on models or strategies, and (c) detailed description of the 'program context' so that readers acquire an accurate and complete understanding of the research design and results obtained." Parts (a) and (b) have already been detailed in the previous paragraphs. For a detailed validation of model implementation, the research team tried to videotape all sessions. Experimental and control teachers were filmed and analysed by an external observer to verify the fidelity of the TPSR and gamification implementation in 10 isolated sessions randomly throughout the intervention (five sessions per group, 550 minutes). Each was distributed in eleven observation periods of 5 min. The camera was installed in the classroom two sessions prior to the beginning of the study to familiarize students and avoid spontaneous behaviours. The instruments used were the same following a similar evaluation structure; both the experimental and control teacher evaluated their own intervention (self-evaluation).

Two experts (trained in the application and evaluation of this type of pedagogical model) checked the reliability of both methodological behaviours and evaluated the frequency that teachers used the hybridization learning models, choosing between 0 (absence of element) or 1 (presence of element). These experts were trained beforehand to check the quality of their record keeping by calculating the inter-observer and intra-observer reliability concordance. Inter-observer reliability was assessed between the new teacher and the expert teacher, guaranteeing an agreement greater than 87%, while intra-observer reliability was assessed by analysing two different moments over 7 days, guaranteeing an agreement greater than 93%. The checklist instrument was composed of a tool for assessing responsibility-based education (TARE) [61], with additional categories for a gamified intervention [62]. The instrument was used to identify the gamification and responsibility elements, respectively. Total agreement (TA) was calculated using the formula: number of total agreements (NTA) divided by agreements (A) plus disagreements (D) (TA = NTA/A + D). The average in each element was analysed to calculate their percentages (%).

The differences between groups were observed in each element: 1) Mechanics (MC), grants rewards and provides feedback on the accomplishment of the challenges (CG = 33.33%; EG = 79.99%); 2) Dynamics (DN), introduces a narrative thread into the session and generates curiosity (CG = 0%; EG = 63.33%); 3) Components (CO), generates missions, realms (groups), roles/status, badges, rankings and markers (CG = 0%; EG = 89.99%); 4) Leadership (L), allows students to lead or be in charge of a group (CG = 0%; EG = 89.99%); 5) Task in group (TIG), the activity is carried out in a group, with the participation by all team members (CG = 16.66%; EG = 79.99%); 6) Autonomy (AU), empowers students to meet cooperative challenges (CG = 33.33%; EG = 96.66%); 7) Problem solving (PS), works with problem situations that force the student to seek solutions through inquiry or investigation (CG = 16.66%; EG = 66.66%); 8) Choice and voice grant (CVG), allows students to reflect, interact and gives them a voice on decisions that affect the development of the class (CG = 16.66%; EG = 43.33%); 9) Group creation and cohesion (GCC), favours the cohesion and creation of groups in the proposed activities (CG = 16.66%; EG = 100%); 10) Role in evaluation time (RET), allows students to play a role in

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assessing learning (CG = 0%; EG = 53.33%); 11) Transfer (T), the possibility of applying the values in class to other contexts in real life (CG = 0%; EG = 39.99%); 12) Set expectations (SE), it is explicit to students what is expected of them, as well as the content that will be addressed (CG = 33.33%; EG = 93.33%). Finally, the average overall usage of the implementation, taking into account the elements mentioned above, was 13.60% for CG and 74.71% for EG.

2.4. Procedure

2.4.1. TPSR intervention program.

The sessions followed Hellison's format [33], but were modified to keep four of its five parts: (1) Initial greeting: the teacher interacted with the students to create bonds with them; (2) Sensitivity talk: the teacher presented the academic and value goals of the session, depending on the responsibility model level; (3) Activity plan: this was the largest part of the practical lesson, where responsibility strategies were included in the different tasks; and (4) Group meeting and self-assessment: at the end of every session, teacher and students shared their perceptions with regard to individual and collective responsibilities and behaviours, as well as the teacher's behaviour, pointing their thumbs up (positive evaluation), to one side (medium) or down (negative evaluation).

2.4.2. Gamification strategies.

First, this intervention took into account the four key motivational elements (RAMP) of Marczewski [63], that a gamified experience should incorporate: Relatedness or the desire to be connected to others in a social community; Autonomy, or the freedom to not be controlled or stifled; Mastery, or the process of becoming skilled at something feeling skills are increasing in direct proportion to the level of challenge; and Purpose, or the meaning of their actions.

It is, however, relevant to highlight that the process of integrating game-design principles within varying educational experiences appeared challenging, and currently, there are no practical guidelines for how to do so coherently and efficiently [64]. However, the following elements, based on the three categories (dynamics, mechanics and components) mentioned by Werbach and Hunter [62], were included as part of the gamified context: (a) Powerful narrative: Seneb's Enigma was designed as the common theme to discover complete health, previously extinct; (b) Challenges: for each mythology, students had to reach two different activities, generally outside the school, each of which included different difficulty levels to challenge the students individually and in groups; (c) Class climate: the focus was on performing the different tasks, such as helping group members, earning points and earning badges, rather than on outperforming others; (d) Immediate feedback: students knew in advance how to perform each activity successfully, the number of points awarded for each task and the level effectively achieved through a social platform; (e) Badges for achievements: students could earn points ("healthy years") to obtain several badges during each unit; and (f) Final status: depending on the mythologies overcome, students reached one of three possible titles (squires, Egyptian "melli" and bearers of Seneb).

2.4.3. Control group methodology.

Direct instruction was the methodology used by the CG teacher based on content/skill development and teacher-centred decisions, without affective-social interaction with the students, causing automatisms in their learning [32].

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Each session was divided into three non-connected parts: (1) Warm-up: students got ready for the class performing predesigned tasks (i.e. joint mobility); (2) Main part: students performed a predesigned set of tasks to improve the selected skills (i.e. badminton hitting drills); and (3) Cool down: students performed lighter tasks to get ready for the next class, focusing on stretching their muscles and following the instructions of the teacher [32].

Virtually every element was monitored and decided on by the teacher, including content selection, managerial control, task presentations, engagement patterns, instructional interaction, pacing and task progression. The teacher decided when practice started and stopped remaining in full control of the class. Students did not have to make decisions besides participation in the different tasks. The teacher's principal goal was paying attention to the result, not to the learning process.

2.5. Statistical analysis

We carried out the initial validation of the instrument by analysing its internal consistency, both in the pre-test and in the post-test for each variable, using Cronbach's alpha test to assess reliability. We then carried out an exploratory analysis of the data using box-and-whisker diagrams and descriptive measurements, detecting significantly different results between groups in the pre-test, so this was taken into account during the inferential analysis.

In a first analysis, a MANOVA of repeated measurements was carried out on the 12 variables obtained from the different PF tests and questionnaire, where we called the intra-subject factor "Time" (with two levels: pre-test and post-test) and we called the inter-subject factor "Group" (with two levels: control and experimental). Additionally, the inter-subject age factor and gender were added as covariates, because we found that this factor could have a significant effect on the measured variables. Additionally, the intervention effect size was estimated using the Cohen's coefficient [65] for small sample sizes [66]. The effect size was considered small when it was 0.2-0.5, medium when it was 0.51-0.8 and large when it was greater than 0.8. Statistical analyses were performed with the Statistical Package for the Social Sciences (IBM SPSS 24.0), establishing the level of significance $p < .05$.

3. Results

Table 2 shows the results of the MANOVA test of repeated measurements at the multivariate level. For inter-subject analysis, there was a significant differences for gender (Wilks' lambda = 0.491; F = 2.698; p = 0.007), but not with the age covariate (Wilks' lambda = 0.736; F = 0.935; p = 0.536) or either group variable (Wilks' lambda = 0.703; F = 1.100; p = 0.388). There were also significant differences in the intra-subject analysis between time and group interactions (Wilks' lambda = 0.197; F = 10.557; p = 0.000) and time and gender (Wilks' lambda = 0.547; F = 2.153; p = 0.028). The fact that the time factor (Wilks' lambda = 0.770; F = 0.775; p = 0.696) was not significant does not mean that there were no differences between the pre- and post-tests, because there were significant interactions with the group factor. This indicates that there may be differences in the time factor (i.e. between pre- and post-test) depending on the group considered (differences for each group separately), as well as taking this factor into account (pre-test and post-test differences between the control and the experimental groups).

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Table 2: Repeated measures Manova (multivariate test)

Factor	Wilks´A	F	p-value	Effect size
Age	0.736	0.935	0.536	0.264
Group	0.703	1.100	0.388	0.297
Gender	0.491	2.698	0.007**	0.509
Time	0.770	0.775	0.696	0.230
Time*Group	0.197	10.577	0.000**	0.803
Time*Gender	0.547	2.153	0.028*	0.453

Note: * $p < .05$; ** $p < .01$

To observe more specifically which variables showed significant differences, the univariate level was analysed. Attention was paid to the variables with previously significant results. For the intra-subject factor, significant differences were obtained in time and group interactions for external motivation with identified regulation (p = 0.033), APA-weekend (p = 0.000), APA-week (p = 0.002), sedentary time (p = 0.000), speed-agility (p = 0.000), agility (p = 0.000) and cardiorespiratory fitness (p = 0.002). There were time and gender interactions for agility (p = 0.021).

Regarding the inter-subject factor, significant differences were obtained in gender for APA-weekend (p = 0.005), APA-week (p = 0.041), speed-agility (p = 0.000), strength (p = 0.000) and cardiorespiratory fitness (p = 0.000). Because there were interactions between the time and group factors for many of the variables, we analysed the differences between the CG and the EG separately for the pre-test and the post-test. Similarly, the variables in the pre- and post-tests should be compared separately for each group. Thus, table 3 reflects the means and standard errors estimated for the participants in the different variables measured in the pre-test and in the post-test, differentiated by group. The p-values obtained by comparing these estimated averages (using Bonferroni correction) are also included.

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Table 3: Intervention multivariate analysis (MANOVA)

Variable	Group	Pre - Test		Post - Test		Pre – Post Comparative	
		Mean	SE	Mean	SE	*p*-value	Dif (SE)
Amotivation	Experimental	3.21	0.28	2.68	0.32	0.17	0.53(0.39)
	Control	1.71	0.25	1.93	0.32	0.53	-0.22(0.34)
	p-value + SE	0.001**	0.41	0.11	0.46		
IM to know	Experimental	4.43	0.26	4.36	0.28	0.83	0.07(0.32)
	Control	5.18	0.23	4.96	0.25	0.43	0.22(0.28)
	p-value + SE	0.05	0.33	0.15	0.40		
IM to accomplish things	Experimental	4.62	0.30	4.46	0.32	0.67	0.16(0.36)
	Control	5.17	0.27	5.27	0.28	0.76	-0.10(0.32)
	p-value + SE	0.21	0.44	0.08	0.46		
IM to experience stimulation	Experimental	3.87	0.30	3.67	0.31	0.61	0.2(0.38)
	Control	4.21	0.27	4.22	0.28	0.98	-0.01(0.34)
	p-value + SE	0.44	0.44	0.23	0.45		
IM general average	Experimental	4.30	0.26	4.16	0.28	0.65	0.14(0.31)
	Control	4.85	0.23	4.81	0.24	0.88	0.04(0.27)
	p-value + SE	0.16	0.38	0.11	0.40		
EM external regulation	Experimental	5.52	0.22	5.94	0.22	0.18	-0.42(0.31)
	Control	6.17	0.20	5.93	0.19	0.38	0.24(0.27)
	p-value + SE	0.05	0.32	0.96	0.31		
EM introjected regulation	Experimental	4.79	0.28	4.58	0.33	0.59	0.21(0.39)
	Control	5.01	0.25	4.88	0.29	0.69	0.13(0.34)
	p-value + SE	0.58	0.40	0.54	0.48		
EM identified regulation	Experimental	4.86	0.25	5.40	0.23	0.05	-0.53(0.27)
	Control	6.02	0.22	5.68	0.20	0.17	0.34(0.24)
	p-value + SE	0.002**	0.36	0.39	0.33		
PA in school	Experimental	2.93	0.18	3.28	0.18	0.10	-0.35(0.21)
	Control	2.88	0.16	3.23	0.16	0.06	-0.35(0.18)
	p-value + SE	0.84	0.26	0.85	0.26		
APA (weekday)	Experimental	2.79	0.18	2.95	0.19	0.40	-0.16(0.19)
	Control	3.08	0.16	3.19	0.17	0.54	-0.11(0.17)
	p-value + SE	0.27	0.26	0.42	0.28		
APA (weekend)	Experimental	2.13	0.19	3.34	0.17	0.000**	-1.21(0.20)

	Control	2.95	0.17	2.57	0.15	0.03*	0.38(0.17)
	p-value	0.005*	0.28	0.003**	0.24		
	+ SE						
	Experi-mental	2.53	0.15	3.11	0.16	0.000**	-0.58(0.14)
APA (week)	Control	3.03	0.14	2.94	0.14	0.47	0.09(0.12)
	p-value	0.03*	0.23	0.47	0.23		
	+ SE						
	Experi-mental	2.94	0.11	2.38	0.11	0.000**	0.56(0.12)
Sedentary Time	Control	2.43	0.10	2.74	0.10	0.008**	-0.31(0.11)
	p-value	0.003**	0.16	0.04*	0.16		
	+ SE						
	Experi-mental	13.24	0.22	11.65	0.22	0.000**	1.59(0.12)
SPD-AGI	Control	12.80	0.19	12.30	0.19	0.000**	0.50(0.11)
	p-value	0.18	0.32	0.04*	0.31		
	+ SE						
	Experi-mental	1.55	0.06	1.68	0.07	0.000**	-0.13(0.03)
Strength	Control	1.57	0.05	1.61	0.06	0.17	-0.04(0.03)
	p-value	0.83	0.09	0.51	0.10		
	+ SE						
	Experi-mental	15.32	0.49	12.58	0.53	0.000**	2.74(0.27)
Agility	Control	13.78	0.43	13.43	0.47	0.16	0.35(0.24)
	p-value	0.03*	0.71	0.27	0.77		
	+ SE						
	Experi-mental	4.14	0.40	5.06	0.40	0.001**	-0.92(0.27)
CF	Control	4.98	0.36	4.59	0.35	0.11	0.39(0.24)
	p-value	0.15	0.58	0.42	0.57		
	+ SE						

Note: * p <.05; ** p <.01; SE= standard error; PA= physical activity; APA= afterschool physical activity; BMI= body max index. CF= cardiorespiratory fitness; SPD-AGI: speed/agility.

It is important to indicate that in the pre-test there were significant differences between groups in amotivation (p = 0.001), external motivation with identified regulation (p = 0.002), APA-weekend (p = 0.005), APA-week (p = 0.03), sedentary time (p = 0.003) and agility (p = 0.03). However, it is also relevant to remark that there were significant differences in the post-test for EG with APA-weekend (p = 0.003), sedentary time (p = 0.04) and speed-agility (p = 0.04). Comparing the effect of the intervention by observing the results between pre-test and the post-test for each group, it can be seen that, for the CG, there are only significant differences in speed-agility (p = 0.000), APA-weekend (p = 0.03) and sedentary time (p = 0.008), but the last two variables had a lower value than pre-test. The results for the EG were significantly better in all physical fitness variables: speed-agility (p = 0.000), strength (p = 0.000), agility (p = 0.000) and cardiorespiratory fitness (p = 0.001). Moreover in APA-weekend (p = 0.000), APA-week (p= 0.000) and sedentary time (p = 0.000).

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4. Discussion

The main purpose of this study was to verify whether a hybrid educational programme in PE classes based on TPSR and gamification could increase motivation, PF and PA and reduce the state of amotivation and sedentary time.

There has been no study based on the hybridization of pedagogical models that has evaluated variables directly related to motivation. Notwithstanding, only two hybrid experiences [43,45] found improvements in any of the three basic psychological needs (BPNs) which affect motivation. Menéndez-Santurio et al. [43] found significant positive improvements in student's relatedness with an intervention based on sport education and TPSR. Gil-Arias et al. [45] studied the impact of hybrid teaching games for understanding and sport education, reporting significantly higher mean scores in praise for perceived autonomous behaviour and enjoyment in the experimental groups. Other studies have followed SDT strategies in PE interventions using an isolated MsBP [38-42,44,46]. Burgueño et al. [44] examined the influence of sport education on BPN satisfaction in a basketball intervention and showed an improvement for autonomy, competence and relatedness need satisfaction. Furthermore, Shannon et al. [46], using an intervention based on Healthy Choices Programme, demonstrated improvements in moderate to vigorous PA partially by increasing children's perceptions of the support for autonomy, BPN satisfaction and intrinsic motivation.

Contrary to the conclusions of these studies, the results observed in the current study indicated that the implementation of a hybrid programme did not contribute significantly to either the improvement of variables such as intrinsic motivation or extrinsic motivation, or to the reduction of the state of amotivation. Other studies [18,67,68] and a systematic review [28] whose results were also opposite to ours, were obtained in isolated gamified interventions with a significant result in motivation. However, none of them measured motivation through SDT or with a validated questionnaire, but rather with a self-elaborated one [67] or with open questions [68]. Only Férriz-Valero et al. [18] found improvements in extrinsic motivation, but not in intrinsic motivation using a validated questionnaire to assess motivation.

On the other hand, our findings coincide with other studies [16,17,20,22,23] that ratified some mechanics used in classroom gamification (i.e. competitive context, badges or leader boards) as harmful to motivation. According to Deci et al. [22] a combination of a reward (in the form of badges or coins), leader boards and competition affected intrinsic motivation. Highly motivated students also showed decreased interest over time due to the relative novelty of gamification [17,20].

The results observed in the present study indicate that the implementation of a hybrid programme based on TPSR and gamification contributes significantly to the improvement of variables such as speed-agility and APA-weekend, thus reducing sedentary time. The data support the conclusions of González-Villora et al. [35], where combined benefits in the physical/motor, cognitive, affective and social domains were only observed when merging different pedagogical models related to the intervention of an isolated pedagogical model. However, TPSR has never been hybridized with gamification strategies. The hybridizations of pedagogical models in the scientific literature with TPSR as the protagonist have been related to the improvement of psychosocial variables and personal and social development [43,69,70]. However, the variables related to health, physical-motor and cognitive aspects have never been analysed through pedagogical hybridizations [35], as in our intervention, which demonstrated that, despite reducing motor physical involvement in the early stages of applying the model, their levels of speed-agility and APA-weekend were improved, reducing sedentary time in the adolescents. Our results, largely obtained by activities carried out outside of school,

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would be in line with the studies proposed by Arundell et al. [8], who suggested that the afterschool period is an important time for enhancing PA levels and reducing sedentary time in childhood and adolescence. Conversely, a possible reason why PA in school has not significantly improved may be the PE sessions themselves, because are based on practice exercise regardless of the type of methodology used. For this reason, it will be so relevant to incorporate this educational programme to current curricular requirements in order to promote PA during PE lessons [71] and afterschool [8].

Strengths and limitations.

Some limitations in this study are that it may not be a sufficient and optimal representation of the school-age population. Consequently, this intervention study may consider the unequal distribution of the participants. It would be convenient not to extend the post-intervention tests until dates close to the evaluations established by the educational centres, due to possible experimental deaths. Moreover, the performance of questionnaire and physical fitness test were determined according to the time assigned in the timeline hours of each group as a consequence of the curricular organization school.

A huge limitation, as has been seen in the discussion, is the non-consideration of the individual context of choosing whether or not to be included in the gamified experience. It has been proven that freedom of choice affects the state of motivation in long-term experiences [17]. Due to the time difficulty and the number of trained and qualified personnel for the test days, both at the beginning and at the end of the intervention, the evaluators were not the same at both period. This could be a limitation, although they were previously trained. Another variable that could affect the reliability of the results would be the activity carried out after school hours. The number of days per week students received extra PA training should be considered because this could affect the final scores. Future studies might consider the use of accelerometry, which would allow a more precise evaluation of daily physical activity.

5. Conclusions

The results obtained with the intervention suggest that the use of a hybrid programme based on TPSR and gamification strategies improved speed-agility variable and the APA on weekends, reducing the time spent on sedentary behaviour, but did not improve motivation variables. Teachers should consider these findings, as potential drawbacks may hamper the outcomes they are trying to cultivate. Although the conclusions could be contradictory, everything indicates that, attending to the scientific literature previously mentioned, there are several variables (competitive context, rewards, badges or leader boards) that could alter the states of motivation in adolescents, or that they were even already self-motivated. That would explain the enhancements achieved in terms of PF, PA and sedentary time.

Decision-makers and administrators for education should consider the inclusion of innovative programmes and their hybridization as a tool to guarantee an optimal motivational state and, therefore, a healthier and more active lifestyle among adolescents. Such programmes should be conscientiously structured depending on the educational context where they are applied. Future studies involving larger sample sizes could confirm or contrast these preliminary findings..

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