CAN A GAMIFIED PROPOSAL IMPROVE KNOWLEDGE AND ATTITUDES TO PERFORM CARDIOPULMONARY RESUSCITATION? A PILOT STUDY WITH SECONDARY SCHOOL STUDENTS FROM CANTABRIA

¿UNA PROPUESTA GAMIFICADA PUEDE MEJORAR LOS CONOCIMIENTOS Y ACTITUDES PARA REALIZAR UNA REANIMACIÓN CARDIOPULMONAR? ESTUDIO PILOTO CON ALUMNADO DE SECUNDARIA DE CANTABRIA

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Abstract

The objective of this study was to analyze the knowledge and attitudes towards Basic Life Support (BLS) acquired through a gamified proposal. A comparative study was carried out with Compulsory Secondary Education students [control group (CG; classical teaching) and experimental group (EG; gamified proposal)]. An *Ad Hoc* questionnaire of 10 questions was used to evaluate knowledge and an attitude questionnaire towards BLS in 65 students (30 women) with a mean age of 14.14 ± 0.43 years. The results of the total number of correct answers between the CG and the post-intervention EG were not significant ($p > 0.050$), but they were significant in both groups with respect to the pre-intervention questionnaire [i.e., CG ($p < .050$). 001); EG ($p < .001$)]. In the post-intervention attitude questionnaire, EG scores increased in self-perception ($p < .001$), intention to perform BLS ($p = .011$) and positive motivation ($p = .006$), and amotivation score decreased ($p = .027$), but there were no changes in CG ($p > .050$). A gamified proposal produces the same learning as the traditional method and, in addition, increases perceived self-efficacy, positive motivation and intention to perform BLS, and decreases amotivation.

Keywords: Basic life support, high school students, first aid, physical education, questionnaire.

Resumen

El objetivo de este estudio fue analizar los conocimientos y las actitudes hacia el Soporte Vital Básico (SVB) adquiridos mediante una propuesta gamificada. Se realizó un estudio comparativo con estudiantes de Educación Secundaria Obligatoria [grupo control (GC; enseñanza clásica) y Grupo experimental (GE; Propuesta gamificada)]. Los instrumentos empleados fueron: cuestionario Ad Hoc de 10 preguntas para la evaluación de conocimientos y el cuestionario de actitud hacia el SVB. Participaron 65 estudiantes (30 mujeres) con una edad media de 14.14 ± 0.43 años. Los resultados del numero total de respuestas correctas entre el GC y GE post intervención no fueron significativos ($p > .050$), pero si aumentaron en ambos grupos respecto al cuestionario pre intervención [i.e. GC ($p < .001$); GE ($p < .001$)]. En el cuestionario de actitudes después de la intervención, han aumentado las puntuaciones en el GE en autopercepción ($p < .001$), en la intención de realizar SVB ($p = .011$) y en la motivación positiva ($p = .006$) y ha disminuido la puntación de la amotivación ($p = .027$), pero no ha habido cambios en el GC ($p > .050$). Podemos concluir que una propuesta gamificada, produce el mismo aprendizaje que el método tradicional y además aumenta la autoeficacia percibida, la motivación positiva y la intención de realizar SVB, y disminuye la amotivación.

Palabras clave: soporte vital básico, alumnado de secundaria, primeros auxilios, educación física, cuestionario

Introduction

Basic life support (BLS) training is recommended in schools, but there is limited research on which methods are best (Semeraro et al., 2024). Teaching methods have been changing from the beginnings of first aid and BLS teaching to the present (Lago-Ballesteros et al., 2018). Thus, a traditional teaching of about 50 minutes, considered the "gold standard", has been used in the past, and today there are a variety of training methods, ranging from massive training to small training pills (Cons-Ferreiro et al., 2023), to the so-called active methodologies, among which are educational "scape rooms" (Fundación MAPFRE, 2019), "augmented reality" (Navarro Patón & Mecías Calvo, 2023) or "gamification". Gamification is a non-evaluative, competitive training methodology with high emotional involvement that seeks to increase attention and motivation, which influences learning (Otero-Agra et al., 2019). The use of gamification in Physical Education has been studied with benefits such as increased student motivation (Arufe-Giráldez et al., 2022a; Fernández-Río et al., 2020; Flores-Aguilar et al., 2023; Parra-González et al., 2021), it helps to improve autonomy and responsibility (Valero-Valenzuela et al., 2020), increases academic performance (Melero-Cañas et al., 2021), which allows a better assimilation of content and greater internalization in learning, being a useful tool to improve the teaching-learning process (Arufe-Giráldez et al., 2022a; Ferriz Valero et al., 2021; Parra-González et al., 2021). For these reasons, this pedagogical model has begun to be used in the teaching of first aid and basic life support (Otero-Agra et al., 2020, 2019; Rodríguez-García et al., 2024). Therefore, it is considered that gamification can be a very effective technique in first aid education to improve learning and help students remember critical skills (Vancini et al., 2023). Therefore, these active methodologies are on the rise, although there is little research on them and current evidence does not clearly show consistent benefits in terms of theoretical knowledge or attitudes towards its implementation compared to other BLS training methods (Cheng et al., 2024).

Therefore, recommendations for standardized teaching and assessment methods are needed to understand the best ways to train children in theoretical knowledge in BLS (Allan et al., 2023). Little is known about which of these training methods motivates students most, since knowledge of how to perform CPR and the use of the automated external defibrillator (AED) are no guarantee that trained people will show a positive attitude to perform CPR in a real situation (Borovnik Lesjak et al., 2021; Kanstad et al., 2011). This attitude is influenced by factors such as the belief in insufficient capacity (Kanstad et al., 2011) and the fear of transmitting diseases or causing injuries (Omi et al., 2008).

Furthermore, in December 2020, the Spanish government took another step in this regard with the approval of Organic Law 3/2020, of December 29, which modifies Organic Law 2/2006, of May 3, on Education (LOMLOE 2020). This law included contents such as first aid, the lateral safety position, or Protect, Alert, and Assist (PAA) behavior, basic CPR, or the use of the AED within the minimum teachings of Compulsory Secondary Education (Real Decreto 217/2022, de 29 de Marzo, Por El Que Se Establece La Ordenación y Las Enseñanzas Mínimas de La Educación Secundaria Obligatoria, 2022) in subjects such as Physical Education.

In this sense, supported by current educational legislation, more studies are necessary to find out what types of training have a similar effect on the learning of BLS knowledge and on the intention, attitude, and self-confidence to apply CPR and use the AED. For all of the above, the objective of this study was to evaluate the viability and effectiveness of a teaching-learning process through a gamified proposal on knowledge regarding BLS, as well as the intention, attitude, and self-confidence of schoolchildren to perform BLS and the use of the AED.

Material and Methods

Study design

In this quasi-experimental study with a control group (Campbell et al., 2012), students from Compulsory Secondary Education participated. As it was a study in a school environment with pre-established groups, a randomized controlled trial design with natural groups was carried out as has been used in other previous studies (Guijarro-Romero et al., 2020).

Sample

A total of 68 secondary education students from a school in Cantabria, aged between 14 and 15, were invited to participate. The following inclusion criteria were taken into account: (a) being enrolled in the 2nd year of compulsory Secondary Education (the year in which the authorizations from the school and the tutor of each classroom were obtained); (b) not suffering from any physical or mental health problem that would prevent participation in the micro-gamification experience;

(c) presenting the informed consent signed by their legal guardians. Of the 68 schoolchildren who were invited to participate, 65 (46.15% girls) met the inclusion criteria.

Instruments, materials and measurements

Before and after the training sessions, students in both groups completed the BLS knowledge questionnaire and the attitudes towards BLS and AED use questionnaire.

BLS Knowledge Questionnaire

To evaluate knowledge in BLS, an ad hoc questionnaire Based on Borovnik et al. (2019) was used. The questions that were formulated in the questionnaire were written based on two dimensions: A) sociodemographic (6): five open (educational center; initials of name and surname; date of birth; gender and grade); one dichotomous ([yes-no]: prior BLS training). B) Knowledge about BLS (10): closed questions with five (5) possible answers, of which only one (1) was correct. Furthermore, in the fifth option, "I don't know" was presented so as not to alter the results and to be able to evaluate the lack of knowledge about the topics discussed in each question. The questions of the questionnaire are presented in Table 2.

To measure the overall level of knowledge of the students (before and after), a scoring system was created, granting one point for each correct answer (these questions were graded as correct (1), incorrect (0)), such that the maximum score was 10. Based on the final score, the level of knowledge that the students had was classified as none, few, enough, quite a few, and many (Table 1).

Table 1

Equivalences Between Scores Obtained and Level of Knowledge in BLS

Scores obtained in the questionnaire	Degree of knowledge in BLS
0-2	None
3-4	Few
5-6	Enough
7-8	Quite
9-10	Many

Attitude Towards Basic Life Support and Automated External Defibrillator Use Questionnaire

The Attitude Towards Basic Life Support and Automated External Defibrillator Use Questionnaire (Borovnik Lesjak et al., 2021) was used to verify the intention and attitudes towards performing BLS, in both groups (CG and EG), before and after the application of the training programs. This questionnaire is composed of 16 items on a Likert-type scale (from 1 to 7; where 1 means "I do not agree at all", 4 means "neutral," and 7 means "totally agree"). The scale consists of the following four factors: self-confidence (for example, "I would start resuscitating because then I could save a person's life"), intention to perform BLS and use the AED (for example, "If I were the only witness when someone collapsed, I would help"), amotivation ("I would prefer to avoid resuscitation because it is too big a responsibility"), and positive motivation ("A BLS course with AED should be a mandatory course in schools").

Training programs

The two trainings used (traditional vs. gamified) were designed in accordance with current international BLS guidelines (Olasveengen et al., 2021).

The traditional training program was conducted following the European Resuscitation Council guidelines (Olasveengen et al., 2021), whereby students received a 40-minute theoretical course with training by the principal investigator, BLS, and AED instructor, based on a keynote lecture supported by a slide presentation, with the entire class-group, in a Physical Education session.

The training program using the gamified proposal was designed following the same instructions as the traditional one (Olasveengen et al., 2021), with a duration similar to the traditional program (50 minutes), and developed in a Physical Education session. For the development of the content, the so-called micro-gamification was chosen (Fernández-Río et al., 2021), using an educational "breakout" on first aid and basic life support using the theme of "Supervivientes" as a narrative,

on the one hand, taking into account the interests of the students and on the other, that it was related to the content to be worked on (Fernández-Río & Flores, 2019). To do this, taking into account the teacher-student ratio (1/25-30), 5 teams of approximately 6 players were formed, who had to overcome the "breakout" that was structured in 5 challenges [(Figure 1) Challenge 1. Introductory video and PAS behavior; Challenge 2. Airways; Challenge 3. Circulation; Challenge 4. CPR; Challenge 5. Use of the Defibrillator] to save their teacher. Since this is a micro-gamification, no missions have been proposed, which would require more time for gamification, but rather challenges have been chosen, understood as the activities that must be carried out by the players (Fernández-Río & Flores, 2019), and completed by the teams within a teaching-learning session (50 minutes), since it is sought that this type of content (first aid and basic life support) can be implemented within the ordinary physical education curriculum as part of it. When a group or groups solved a challenge well, they were awarded an achievement badge (Figure 2). After completing the "breakout", the team that met all the challenges received a “lifeguard” diploma.

Figure 1

Access via Training QR Code to the Gamified Proposal

Figure 2

Badge Model That is Given to the Group Every Time a Challenge is Overcome

Procedure

School principals and physical education teachers, selected for convenience from an educational center (Cantabria, Spain), were contacted, and the researchers personally informed them and explained the purpose of the study, requesting their permission to carry it out. Once approval was received, an informed consent form was sent to the parents, where they were provided with all the necessary information about the study and where it was explained to them that their children's participation was voluntary and that they could withdraw them at any time they considered. The schoolchildren were assigned to the control group (CG) and the experimental group (EG) according to their natural belonging to each classroom (classroom A or B) of the educational center. Before providing the training, the prior knowledge questionnaire about BLS and AED and the attitude questionnaire were passed to the students who agreed to participate. The questionnaires were administered by the principal researcher the day before the training, both to the group that received the traditional training and to the group that received the gamified experience. They were given 20 minutes to complete them. Subsequently, the training method established for it was applied to each group (CG: traditional method; EG: training through a gamified proposal). Although the implementation of the training programs was conducted by a researcher with BLS and DEA accreditation, another researcher supervised all sessions (initial data collection; implementation of the training programs; final data collection after training) to ensure that all research guidelines were followed. After the training, the students were assessed using the same questionnaires and the same procedure as the previous questionnaires (Figure 3). It should be noted that the assessments were carried out by the same evaluator, instrument, and procedure.

Statistical Analysis

The mean and standard deviation were used to express the central tendency of the quantitative data, while frequencies and percentages were used to express the categorical variables. To compare the correct questions answered by both training methods/programs, a proportion analysis was performed on each of the questions asked, before and after the intervention, and between the groups (CG vs. EG) using the Chi-Square statistic. To compare the difference in the correct questions answered in the CG and EG before and after their respective interventions, the Wilcoxon rank test was performed.

Furthermore, the normality of the quantitative data was checked using the Kolmogorov-Smirnov test. Subsequently, the reliability of the different subscales of the attitude questionnaire towards BLS and AED was analyzed using Cronbach's alpha coefficient.

Finally, a two-way ANOVA (time x group) was performed, using time as a repeated measures factor, [i.e., time (pre-training vs. post-training) and group (control group vs. experimental group)] to analyze the possible main effect of these factors on the number of correct answers to the questionnaire on BLS and AED and the attitude variables questionnaire on BLS and AED (perceived self-confidence; intention to perform BLS and AED; amotivation; positive motivation) and their interaction using the Bonferroni statistic. Furthermore, the effect size was calculated in terms of eta squared ($\eta 2$). The association was weak, with values between 0.10 and 0.29; moderate, between 0.30 and 0.49; and strong, between 0.50 and 1.00.

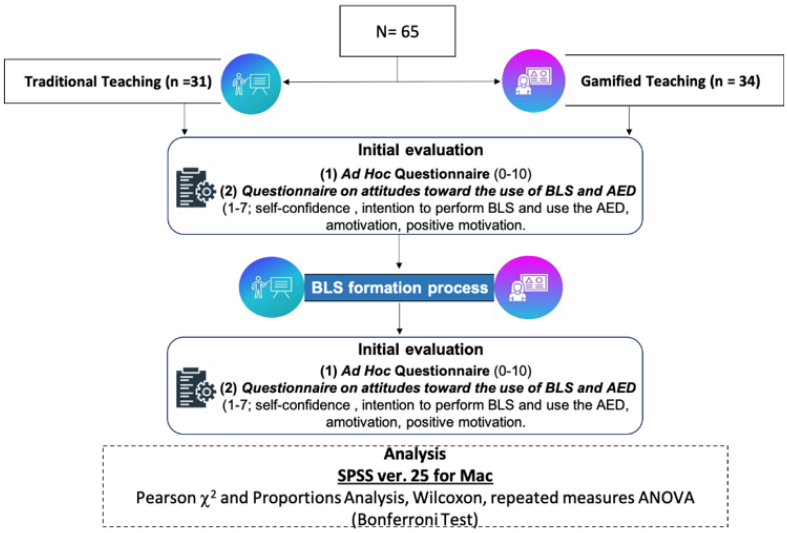
SPSS software (SPSS v.25, IBM Corporation, New York, NY, USA) was used for all statistical analyses. The level of significance was set at $p < .05$.

Ethical Considerations

Ethical approval was obtained by the Ethics Committee of the Universidad de Internacional Iberoamericana in 2024 with code number CR-222. The schoolchildren were treated with respect to the Declaration of Helsinki during their participation in this research.

Figure 3

Research Flowchart



Results

The sample was divided into two analysis groups: the CG (n=31), with an average age of 15.06 years (SD = 0.25) and the EG (n = 34), with an average age of 14.14 years (SD = 0.43). Regarding the gender variable, 46.2% of the participants were women (n = 30) and 53.8% men (n = 35), distributing 12 women and 19 men in the CG and 18 women and 16 men in the GE.

The baseline characteristics of the sample indicate that a total of 29 (93.5%) CG subjects and 29 (85.3%) EG subjects did not receive prior training in BLS. The CG and EG participants were similar in terms of the previous training received (p = .284) and in gender (p = .250), but not in age (p < .001).

The normality test revealed that the data followed a normal distribution [i.e., correct answers score (p = .577), perceived self-confidence (p = .483), amotivation (p = .501), positive motivation (p = .053)], except in the intention to perform BLS and AED (p = .010).

Questionnaire Results on Knowledge About BLS and AED

Table 2 shows the results of correct questions before and after the application of the training programs. In the initial questionnaire it can be observed that there is a similarity in proportions regarding the correct questions of both intervention groups (GC vs GE), except in: How is basic life support correctly performed? (X^2 = 4.546; p = .047) and What do you do if you are not sure if a person is in cardiac arrest or not? (X^2 = 9.622; p = .002), where there are statistically significant differences in favor of the GC. In the comparison of proportions of correct questions after the formation of the groups (GC and EG), not only do the initial differences disappear in favor of the GC, which now indicates a proportional similarity of questions answered correctly in both groups, but in the question What is an AED (automated external defibrillator)? significant differences appear in favor of the EG (gamified proposal; p < .001).

Table 2

Results of the Correct Questions pre-Post Intervention of the Control Group and the Experimental Group

		CG(n = 31)	EG(n = 34)	p-value
How do you recognize a person in cardiac arrest?	CA-pre	16 (53.3%)	14 (46.7%)	.460
	CA-post	24 (52.2%)	22 (47.8%)	.260
	p-value	**.021***	**.021***	
Who can help in case of cardiac arrest?	CA-pre	25 (48.1%)	27 (51.9%)	1.00
	CA-post	28 (53.8%)	24 (46.2%)	.064
	p-value	0.257	0.366	
A person suddenly loses consciousness and falls to the ground. What do you do?	CA-pre	17 (56.7%)	13 (43.3%)	.218
	CA-post	27 (46.6%)	31 (53.4%)	.596
	p-value	**.004***	**< .001***	
How can you check if a person is breathing normally?	CA-pre	15 (53.6%)	13 (46.4%)	.459
	CA-post	25 (48.1%)	27 (51.9%)	.901
	p-value	**.008***	**.002***	
What type of breathing is NOT a sign of life?	CA-pre	23 (57.5%)	17 (42.5%)	.073
	CA-post	25 (50.0%)	25 (50.0%)	.496
	p-value	.414	.059	
How is basic life support performed correctly?	CA-pre	6 (85.7%)	1 (14.3%)	.047*
	CA-post	27 (50.9%)	26 (49.1%)	.270
	p-value	**< .001***	**< .001***	
Correct place for chest compressions during Basic Life Support	CA-pre	23 (51.1%)	22 (48.9%)	.435
	CA-post	27 (45.8%)	32 (54.2%)	.329
	p-value	.206	**.004***	
How are artificial ventilations performed on an unconscious person?	CA-pre	17 (60.7%)	11 (39.3%)	.083
	CA-post	14 (37.8%)	23 (62.2%)	.067
	p-value	.439	**.011***	
What do you do if you are not sure if a person is in cardiac arrest or not?	CA-pre	18 (72.0%)	7 (28.0%)	.002*
	CA-post	11 (44.0%)	14 (56.0%)	.638
	p-value	.108	**.035***	
What is an AED (automated external defibrillator)?	CA-pre	5 (29.4%)	12 (70.6%)	.096
	CA-post	11 (28.2%)	28 (71.8%)	< .001*
	p-value	.134	**<.001***	

Note. CA-pre: Correct Answer pre intervention; CA-post: Correct Answer postintervention; CG: Control Group; EG: Experimental Group.

Pre-post Intervention Knowledge in the CG

The results of the analysis in the CG reveal that there were significant improvements in the knowledge of the following items once the training proposal was applied: How do you recognize a person in cardiac arrest? (p = .021); A person suddenly loses consciousness and falls to the ground. What do you do? (p = .004); How can you check if a person is breathing normally? (p = .008) and How is basic life support performed correctly? (p < .001). There were no improvements or worsenings in the rest of the items studied (p > .05) (Table 2).

Pre-post Intervention Knowledge in the EG

The results of the binomial analysis in the EG reveal that significant improvements occur in the knowledge of the following items once the training proposal is applied: How do you recognize a person in cardiac arrest? (p = .021); A person suddenly loses consciousness and falls to the ground. What do you do? (p < .001); How can you check if a person is breathing normally? (p = .002); How is basic life support performed correctly? (p < .001); Correct place for chest compressions during Basic Life Support (p= .004); How are ventilations performed in an unconscious person? (p = .011), What do you do if you are not sure if a person is in cardiac arrest or not? (p = 0.035), and What is an AED? (p < .001). There were no improvements or worsenings in the rest of the items studied (p > .05) (Table 2).

Results of the Number of Correct Answers pre- and Post-Intervention in the CG and EG

The results regarding the number of correct answers before and after training, both in the CG and the EG, can be seen in Table 4. Before training, the CG had a higher average of correct answers than the EG [F (1, 63) = 6.241; p = .015; $\eta 2$ = 0.090, CI 0.259, 2.328] (Table 3). Once the training programs have been applied, both the CG and the EG begin to have a lot of knowledge, and consequently, the previous differences disappear (p = .440).

There is a significant increase after the application of the traditional training program when the number of correct responses is compared before and after training in the CG [F (1, 63) = 17.639; p < .001; η2 = 0.219, CI -2.571, - 0.913], as occurs in the EG [F (1, 63) = 71.940; p < .001; $\eta 2$ = 0.537, CI -4.174, -2.591].

Table 3

Descriptive Data of the Number of Correct Answers (Mean, Standard Deviation) Depending on the Group (CG vs. EG) and Time (pre-Post)

		CG		EG		
Variable		***M***	***SD***	***M***	***SD***	***p-value* (CG vs. EG)**
Number of correct answers	Pre-training	5.32	2.21	4.02	1.96	**.015***
	Post-training	7.06	2.06	7.41	1.51	.440
	p-value (pre vs. post)	**< .001***		**< .001***		

M:Mean; *SD*: Standard Deviation

Attitudes Towards the BLS Questionnaire Results

Table 4 shows the descriptive statistics of the variables used, the reliability analysis, and the correlation of the questionnaire on attitudes towards the BLS and the use of the AED. The results of the reliability analysis showed adequate values in self-confidence (SC), intention to perform BLS and AED (IP); amotivation (AM); positive motivation (PM). In relation to the correlation analysis, the high and positive correlation between SC, IP, and PM stands out, as does the negative relationship between AM and SC, IP, and PM. The positive and significant relationship between IP and PM also stands out.

Table 4

Means, Standard Deviations, Skewness, Kurtosis, Reliability Analysis and Bivariate Correlations Between the Studied Dimensions of the Questionnaire on Attitudes Towards the BLS and the use of AEDs

Dimensions	*M*	*SD*	S	*K*	α	SC	IP	AM	PM
Self-confidence (SC)	4.94	1.26	-0.94	1.78	.803	1	.588*	-.234*	.498*
Intention to perform (IP)	5.78	1.45	-1.46	1.67	.826	1	1	-.317*	.484*
Amotivation (AM)	3,40	1.68	0.42	-0.49	.761	-	-	1	-.137
Positive motivation (PM)	5.63	1.44	-1.49	2.15	.778	-	-	-	1

M = Mean; *SD* = Standard Deviation; *S* = Skewness; *K* = Kurtosis; *α* = Cronbach's alpha; SC = Self-Confidence; IP = Intention to perform BLS and AED; AM = Amotivation; PM = Positive Motivation; * The correlation is significant at the 0.01 level (Bilateral).

The results of the questionnaire on attitudes towards the BLS and the use of the AED before and after the application of the training programs can be seen in Table 5.

Table 5

Descriptive Data of the Variables Analyzed (Mean, Standard Deviation According to Group (CG vs. EG) and Time (pre-Post) of Completing the Questionnaire on Attitudes Towards BLS and the use of the AED

		CG		EG		
Variable		***M***	***SD***	***M***	***SD***	***p-value* (CG vs. EG)**
Self-Confidence	Pre-training	4.97	0.80	4.85	1.56	.727
	Post-training	5.28	0.89	5.81	0.84	**.019***
	p-value (pre vs. post)	.225		**< .001****		
Intention to perform BLS and AED	Pre-training	5.78	1.27	5.71	1.61	.860
	Post-training	5.81	1.00	6.41	0.74	**.009***
	p-value (pre vs. post)	.905		**.011***		
Amotivation	Pre-training	3.41	1.19	3.50	2.01	.823
	Post-training	3.81	1.28	2.70	1.32	**.001***
	p-value (pre vs. post)	.299		**.027***		
Positive Motivation	Pre-training	5.72	0.80	5.49	1.84	.529
	Post-training	5.82	0.93	6.32	1.12	**.050***
	p-value (pre vs. post)	.744		**.006***		

M: Mean; *SD*: Standard Deviation
*p < .05. **p < .001.

The results of the analysis carried out indicate that before the application of the training programs there were no significant differences in any of the variables studied [i.e., self-confidence (p = .727); intention to perform BLS (p = .860); amotivation (p = .823); positive motivation (p = .529)]. Once the training programs were applied, a significant main effect was found in the group factor with higher values in the EG on self-confidence [F (1, 63) = 5.842; p = .019; $\eta 2$ = 0.087, *CI* -0.969, -0.092], in the intention to perform BLS and AED [F (1, 63) = 7.271; p = .009; $\eta 2$ = 0.107, *CI* -1.037, -0.154] and in positive motivation [F (1, 63) = 4.849; p = .050; $\eta 2$ = 0.075, *CI* -1.022, -0.030]. Regarding amotivation, there is also a significant main effect on the group factor [F (1, 63) = 11.355; p = .001; $\eta 2$ = 0.157, *CI* 0.451, 1.768], but with higher mean scores in the CG than in the EG.

In the pre-post comparisons in the CG, no significant effects were found in any of the variables studied [i.e., self-confidence (p = .225); intention to perform BLS and AED (p = .905); amotivation (p = 0.299); and positive motivation (p = .744)].

In the pre-post comparisons in the EG, statistically significant differences were found with a higher post-intervention score in self-perception [F (1, 63) = 16.623; p <.001; $\eta 2$ = 0.214, CI -4.174, -2.591]; intention to perform BLS and AED [F (1, 63) = 6.813; p =.011; $\eta 2$ = 0.100, CI -1.229, -0.163]; and positive motivation [F (1, 63) = 8.200; p = .006; $\eta 2$ = 0.119, CI -1.415, -0.251], and with lower scores in amotivation [F (1, 63) = 5.136; p = .027; $\eta 2$ = 0.078, CI -1.513, -0.095].

Discussion

The main findings of this study were: (1) although content such as those studied in this research is already included in the school curriculum, the majority of respondents said they had not received any type of training on BLS; (2) after a 50-minute gamified training proposal, students improve their knowledge as much as a traditional proposal, considered the gold standard of BLS training; and (3) a gamified approach to teaching BLS generates greater positive motivation, self-confidence, and intention to teach BLS than a traditional approach and, in turn, decreases amotivation. In this sense, the theory of gamified learning (Landers, 2014) tells us that this may be because its application in educational contexts, as is the case, has been used to increase engagement and motivation, in such a way that, on the one hand, intrinsic motivation is increased because students feel more motivated to participate in those activities that are most attractive and fun for them, and on the other hand, it improves active learning because it encourages active participation and practical learning, which can improve the retention of knowledge and skills (Ferriz-Valero et al., 2023). Based on the general results obtained, it can be said that training students through gamification is another training method as effective as those used so far (Lago-Ballesteros et al., 2018).

More specifically, the initial results indicate a lack of training and knowledge on the part of the students participating in this research on BLS, since in the EG the knowledge was low and, in the CG, sufficient, data similar to those reported by Semeraro et al. (2017) in their study with Italian children and adolescents, or Losa-Ballesteros et al. (2020) in their study with adolescents from Albacete (Spain). These findings may be the result of teachers' lack of preparation and expertise (Navarro-Paton et al., 2020) or the shortage of material and equipment necessary to carry out the training (Salvatierra et al., 2017).

Once the training has been applied, as in previous studies (Banfai et al., 2017; Borovnik Lesjak et al., 2022; Cerezo Espinosa et al., 2018; Cons-Ferreiro et al., 2023; Rodríguez-García et al., 2024), observe that the students in this study have the capacity to learn knowledge related to BLS, both those of the CG and those of the EG, although it is true that those of the gamified proposal achieve a higher overall average. Taking into account the theory of gamified learning (Landers, 2014), this may be because the incorporation of this methodology in the educational process can increase students' motivation and commitment (Huamaní Quispe & Vega Vilca, 2023; Poveda-Pineda et al., 2023), and thus improve academic performance and learning, obtaining better academic performance.

Specifically, both the CG and the EG improved in the number of correct responses to identify cardiac arrest, identification of the so-called “normal breathing”, and actions to take when a person falls to the ground, elements of vital importance since these two topics include the activation of the Emergency Medical Service (EMS), knowledge that could be enough to save a person's life (Cave et al., 2011). That schoolchildren know how to identify cardiac arrest and activate the EMS may be enough, since the alerter can be guided from the emergency center to their arrival (Navarro-Patón et al., 2017). This allows EMS to arrive as quickly as possible, significantly increasing the victim's chances of survival (Soto-Cámara et al., 2019).

Regarding the compression-ventilation ratio in the application of external cardiac compressions, the schoolchildren in both groups also significantly improved the number of correct answers, so we could say that they showed a good assimilation of this concept, as indicated in previous studies (Borovnik Lesjak et al., 2022; Cons-Ferreiro et al., 2023; Li et al., 2018; Rodríguez-García et al., 2024), since this is not a simple task (Martínez-Isasi et al., 2022). Although it should be noted that theoretical knowledge of these parameters does not directly imply having sufficient practical skills to perform quality external cardiac compressions (Fijačko et al., 2024). Finally, regarding knowledge of the AED, the schoolchildren who received the gamified training showed a greater number of correct answers on this content, results that are in line with those obtained by Semeraro et al. (2017), where the participants had similar knowledge about this device. This increase in knowledge could lead to a faster and more effective response to a cardiac emergency, as schoolchildren with knowledge and training can act immediately in the event of cardiac arrest (Basanta-Camiño et al., 2017).

On the other hand, the results of the analysis of variables from the questionnaire of attitudes towards BSL and use of the AED for the gamified proposal showed that students trained in this method gave higher scores in the intention to perform BLS and use of the AED, in self-confidence, and in positive motivation compared to those trained by the traditional method, as in previous studies, which indicate that students trained with a gamified approach showed higher scores in the intention to perform BLS and use the DAE, in self-confidence, and in positive motivation compared to those trained using the traditional method (Rodríguez-García et al., 2024), it may be due to the fact that gamification increases motivation and reduces cognitive load, improving engagement and learning outcomes (Baah et al., 2024), or also that the use of gamified materials in teaching can have a positive effect on students' perceived motivation and academic performance (Kalay & Arikan, 2023). For this reason, special emphasis should also be placed on these aspects during BLS courses for schoolchildren, since, through gamified proposals adapted to the level of understanding and development of the participants, they are being offered a better self-perception towards the application from the BLS (Borovnik Lesjak et al., 2021); therefore, it would be contributing to reducing the most commonly reported reasons for not performing CPR (Kanstad et al., 2011; Omi et al., 2008).

The above can give an idea of the efforts that educators must make to motivate students to undergo training in BLS and AED (Borovnik Lesjak et al., 2021; Wissenberg et al., 2013) or in regular training to strengthen confidence in oneself (Matsubara et al., 2015). Considering the importance of motivation towards BLS, it is worth noting that in this study there were differences between the groups in the positive motivation variable, which suggests that these contents implemented through gamified proposals can motivate students more (Arufe-Giráldez et al., 2022b). Furthermore, students who were trained using the gamified proposal showed greater self-confidence and willingness to perform BLS than CG students (Cons-Ferreiro et al., 2023; Rodríguez-García et al., 2024). This may be due to active learning, with proposals through challenges and the collaboration necessary to achieve and overcome them, achieve better results because students feel more motivated, involved, and immersed in the learning process (Monteiro-Carneiro et al., 2022). Regarding self-confidence, this could be reinforced in the group that received the gamified training, adapting to the level of understanding and development of the participants through the simulated scenario of "Survivors" (a television program), through which they were offered a better self-confidence perception towards the application of BLS (Borovnik Lesjak et al., 2021).

As with any study, this has certain limitations that we proceed to list below: 1) we must highlight the size of the sample, which, although a small sample of students is used, is a first step in evaluating gamification as a training method in knowledge and attitudes towards CPR and the use of the AED, so further studies with larger samples would be necessary to help generalize the results of this research. Therefore, the results of this study only suggest that these positive results were achieved in this specific context. 2) We must highlight that only theoretical knowledge and attitudes were evaluated. It is not known what impact this training method would have on learning practical skills and the quality of CPR and AED use. This should be taken into account with a view to possible transfer to action in the event of a real cardiac arrest, since theoretical knowledge does not always imply acquiring the skills necessary for practical action. 3) An ad hoc questionnaire was used to assess both knowledge and attitudes, with the limitations that this instrument implies since, on the one hand, it is not validated, and on the other, respondents usually respond in a socially expected way. 4) Finally, it should be noted that knowledge was only evaluated immediately after receiving the training, and no medium- or long-term follow-up was carried out to evaluate the degree of forgetting, which can give a false impression that the content is mastered. Furthermore, not knowing how and how much is forgotten would mean not being able to implement reinforcement or review strategies to mitigate this forgetting.

Conclusions

Based on the results of this research, it can be said that a BLS training program using a gamified proposal achieves learning equal to or superior to the traditional method, considered the “gold standard” by international organizations in BLS (Olasveengen et al., 2021), and can be implemented in a single 50-minute session.

Furthermore, the gamified proposal causes students to have greater positive motivation, perceived self-efficacy, and intention to perform CPR and use the AED than in the traditional program and, at the same time, less amotivation, therefore contributing to reducing the reasons why the SVB is not offered.

The findings of this study, in terms of the acquisition of theoretical knowledge, positively influence the future design and implementation of BLS training programs in school environments, since it has been proven that, in a standard 50-minute session, students in this study are able to improve their knowledge. Therefore, future research is encouraged to

implement training programs of this type to verify their viability in other geographical areas or with students of other ages and educational contexts, and to carry out longitudinal studies, with and without refresher courses, to evaluate whether the motivational benefits of gamification translate into sustained knowledge or retention of skills over time.

Ethics Committee Statement

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee: Universidad Internacional Iberoamericana (registration code CR-222, March 1, 2024).

Conflict of Interest Statement

The authors declare no conflicts of interest. No entity had any influence on the study design, data analysis, or interpretation of the results.

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Authors' Contribution

Conceptualization, A.R.-G., G.R.-G., R.N.-P., and M.M.-C.; Methodology, A.R.-G., G.R.-G., R.N.-P., and M.M.-C.; Validation, A.R.-G., G.R.-G., R.N.-P., and M.M.-C.; Formal Analysis, R.N.-P.; Investigation, A.R.-G., G.R.-G., R.N.-P., and M.M.-C.; Data Curation, A.R.-G. and G.R.-G.; Writing—Original Draft, R.N.-P. and M.M.-C.; Writing—Review and Editing, A.R.-G., G.R.-G., R.N.-P., and M.M.-C.; Visualization, A.R.-G., G.R.-G., R.N.-P., and M.M.-C.; Supervision, R.N.-P. and M.M.-C.; Project Administration, R.N.-P. and M.M.-C.. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The data is not available in accordance with Regulation (EU) of the European Parliament and of the Council 2016/679 of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data (GDPR).

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