The “\$in TIME” Gamification Project: Using a Mobile App to Improve Cardiorespiratory Fitness Levels of College Students

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Abstract

Objective: To examine the effects of a gamification teaching program, including the use of a game-based mobile app on the cardiorespiratory fitness (CRF) levels of college students.

Materials and Methods: This study included a total of 117 college students (20.1 ± 2.9 years). They belonged to two different class groups, one formed the intervention group (IG, $n = 58$) and another one the control group (CG, $n = 59$). IG college students followed a 16-week gamification teaching program focused on encouraging physical activity (PA) through a game-based mobile app. The program was named “\$in TIME” and set in the “In Time” science fiction movie. Each student belonging to the IG had a countdown on their mobile app so they had to perform learning and PA challenges to gain time. Thus, they had to run or cycle 3 to 5 days per week to gain time of life. The CG followed a traditional teaching methodology instead. CRF was assessed preintervention and postintervention using the 20-meter shuttle run test (20mSRT).

Results: The stages completed in 20mSRT and the estimated maximal oxygen consumption at postintervention were significantly different between groups ($P < 0.001$, $d \leq 0.7$), with a mean difference of 1.2 stages and $3.69 \text{ mL}/(\text{kg} \cdot \text{min})$, respectively. Analysis within group showed a significant pre-post improvement only in the IG of 1.4 stages ($P < 0.001$).

Conclusion: A gamification program, including the use of a game-based mobile app in a university setting, had a significant effect on the CRF in college students, in comparison with a CG that follows a traditional teaching methodology.

Keywords: Aerobic fitness, Health, Innovation, University, Young adults

Introduction

RESEARCH HAS CONSISTENTLY SHOWN LEVELS of physical activity (PA) decrease with age.¹ Indeed, adults do not generally meet the recommended PA levels established by the Public Health Physical Activity Guidelines.^{2,3} Regular practice of PA has been linked to an increase in physical fitness levels.⁴ Specifically, there is strong evidence that supports that cardiorespiratory fitness (CRF) is the strongest marker of present and future health in young people.^{5,6}

In a university setting, there is a decrease in the concern for a healthy lifestyle as well as a decrease in the practice of PA.⁷ As a consequence of the university way of life, college students have been considered a target population due to their susceptibility to acquire unhealthy habits.⁸ This unhealthy lifestyle may derive from the changes that a college

student undergoes when he no longer has the lifestyle he used to, that is, a lifestyle regulated by his family and the school setting.⁷ These lifestyle changes often include an increase in the number of hours devoted to study, having a night schedule for leisure activities, and an increase in stress due to pressure from work or study.⁷ Collectively, studies have shown that college students report lack of time as the main barrier for the practice of PA.^{7,9} Furthermore, lack of time or the use of time to do sedentary activities have been related to lower CRF levels among college students.¹⁰ To counter this, effective interventions that promote healthy lifestyle behaviors among students in university settings are needed.¹¹

Given the unhealthy lifestyle of young adults and the implementation difficulty of several PA interventions, using gamification (i.e., the application of game design elements in non-game contexts) might be of help to motivate college

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students and to promote changes in health behaviors such as PA.^{12,13} Although there is a growing body of literature on games with the aim to increase PA, the majority of them are non-mobile “exergames,” which focus on exercise sessions at home.^{3,14} One of the main limitations of these games is that they fail to transfer PA to daily life, and therefore fail to change actual activity behavior in the long term. To take the game beyond someone’s home into his or her everyday life, mobile phone apps along with the use of gamification have been reported as an effective tool to increase PA and, consequently, CRF levels.¹⁵

Given the lack of time being one of the main barriers for college students to increase their CRF levels,^{7,10} and the potential of gamification and game-based mobile apps to increase PA levels,^{16,17} the aim of this study was to examine the effects of a 16-week gamification teaching program, including the use of a game-based mobile app, whereby college students had to manage their daily life time, on their CRF levels.

Materials and Methods

Study design

This study had a quasiexperimental design with two arms (i.e., intervention group [IG] and control group [CG]). The whole investigation took place from February to June 2017.

Participants

A total convenience sample of 117 college students (20.1 ± 2.9 years old; 78.6% males) took part in this study. Participants were recruited by a lecturer in “Basis of Physical Education and Sport,” a subject that is taught in the degree of Physical Activity and Sport Sciences (Faculty of Sport Sciences, University of Granada, Spain). Two different class sections of the same subject participated. An IG made up of 58 college students (75.9% males) took part in the “\$in TIME” gamification-based program (see following section) and a CG ($n=59$, 81.4% males) followed a traditional teaching methodology with the same subject’s contents than the IG. The main difference between the two groups, apart from the teaching methodology followed by each of them, was that the CG was not encouraged to meet the PA recommendations. For the allocation of the participants to each group, first, the students freely chose a class section based on their time schedule preferences, and afterward, the Head of the Department of Physical and Sports Education randomly allocated two different lecturers to each group.

A comprehensive verbal description of the purpose of the study was given to all participants and written consent was required from them. The study protocol was approved by the Review Committee for Research Involving Human Subjects at the University of Granada (approval no.: 421/CEIH/2017).

The “\$in TIME” gamification program

The “\$in TIME” gamification characteristics are provided in Table 1 and have been described elsewhere.¹⁸ A gamification-based program was implemented by an experienced lecturer at the University of Granada. The intervention consisted of 44 gamification-based learning lectures and 16 weeks of PA training. The gamification technique¹⁹ was used as a motivational teaching tool to encourage college

students to overcome a set of learning challenges and to meet PA recommendations the highest possible number of weeks.³ Students needed to do at least 150 minutes per week of moderate PA, or 75 minutes per week of vigorous PA.³ The “\$in TIME” (“\$in” means “without” in Spanish) program was set in the “In Time” movie. In short, the college students of the IG were contextualized in the year 2117 and were told that the population was no longer getting old after their 18th birthday. In contrast, from that moment on, every human being only had 1 year of life, unless they worked hard to gain more time. The teacher played the role of the *Time-keeper* who lead the rebellion against the *Metronomer*, a character who was invented to have the power to determine the time of the *Fenis Ghetto* (i.e., population represented by the college students of the IG). The rebellion was formed by all the college students of the IG taking part in it as *Trojans of Education*. This group definition was given to the students since they were expected to expend all their time fighting for a different and creative education.

The main idea on which the program was sustained was that college students’ lives depended on time and therefore the way they expended their time was an opportunity for them to enrich their lives through learning. The students gained time after successfully overcoming learning or creativity challenges and by practicing PA every week. While in the “In Time” film, the population has a 1-year life countdown on their forearm, in this gamification program, a mobile app was designed so that each student could manage his/her own time by doing different activities (Fig. 1). Thus, for the gamification-based experience, the students had the aim of avoiding their counter reaching 0. One of the main activities they had to do to gain time was to run or cycle 3 to 5 days per week. The motivational approach of the gamification was based on gaining time and on classifications. To score, participants had to meet PA recommendation every week and, depending on the quantity (i.e., 3 or 4 times/week registered by mobile phone applications), they were rewarded with a specific score. This classification could be found by the students in the app under the Player’s section. The participants could also check the experience points (XP) gained through the completion of the challenges in this section. These XP gave them the opportunity to have several privilege cards and therefore time benefits. In summary, the gamification program consisted of encouraging college student to weekly meet the internationally accepted PA recommendations³ during a 16-week period by doing PA such as running or cycling.

Measurements

Cardiorespiratory fitness. The 20-meter shuttle run test (20mSRT) was used to assess CRF level.²⁰ This test was monitored by trained evaluators. Participants had to run back and forth between two lines set 20 m apart with an initial velocity of 8.5 km/h, which was increased by 0.5 km/(h·min). The total number of completed stages was registered and an estimation of maximal oxygen consumption [VO_2max , mL/(kg·min)] was calculated using Léger equation for adults.²⁰ The stages completed and the estimated VO_2max at preintervention were standardized as follows: $z\text{-score} = (\text{value} - \text{the sample mean}) / \text{standard deviation (SD)}$. The $z\text{-scores}$ at postintervention were computed for each

TABLE 1. CHARACTERISTICS OF A GAME FOR HEALTH: \$IN TIME

Health topic(s)	Cardiorespiratory fitness benefits for health
Targeted age group(s)	19–20 years old
Other targeted group characteristics	Unhealthy habits; lack of time for PA; high frequency of night schedules for leisure activities; stress due to work or study.
Short description of game idea	\$in Time's gamification project revolves around the idea that life depends on how you use your time. Participants are told that the population is no longer getting old after their 18th birthday. In contrast, from that moment, every human being has only 1 year of life, unless they work hard to gain more time. Thus, each participant has a countdown in a mobile-based app that allows them to fulfill their basic needs and accept different learning and physical challenges to sum time to this countdown and extend life.
Target player(s): (check one)	☐ Individual ☐ Dyad ☒ Small group ☐ MMOG ☐ Other:
Guiding knowledge or behavior change theory(ies), models, or conceptual framework(s):	Gamification. Self-determination theory (i.e., from the perspective of increasing motivation to promote behaviors). Peer-led interventions (i.e., peer learning). Health belief model.
Intended health behavior changes:	Cardiorespiratory fitness improvement
Knowledge element(s) to be learned:	Participants are encouraged to join a district (i.e., different groups within the class) and perform challenges as a district to gain time. Furthermore, participants are encouraged to individually increase their life time.
Behavior change procedure(s) (taken from Michie inventory) or therapeutic procedure(s) employed:	Capability, motivation, and opportunity.
Clinical or parental support needed? (please specify):	No
Data shared with parent or clinician:	☐ Yes ☒ No
Type of game: (check all that apply)	☒ Active ☒ Action ☐ Adventure ☒ Role-playing ☐ Simulation ☐ Strategy ☐ Sport ☐ Casual ☒ Educational ☐ Other:
Story (if any) Synopsis (including story arc):	Year 2117. From that moment, every human being has only one more year of life. In this context, the only way to extend the life is by working hard to gain more life time. Every person of the <i>Fenis Guetto</i> has a life timer installed in their mobile-based app that indicates the countdown before having a heart attack. In the city of Granada, the <i>Metronomist</i> is the criminal director of the Bank of the Time and has the power to determine the time of the <i>Guetto</i> . The hope for the city is a master, best known as <i>Timekeeper</i> , who leads a rebellion against the System defined as <i>Trojans of the Education</i> . He suggests a lifestyle (defined as \$in Time project) based on learning and improving cardiorespiratory fitness levels as a more enriching opportunity to gain time than any other.
How the story relates to targeted behavior change:	Participants of the \$in Time project have to upload their Runtastic's session (i.e., running or cycling sessions) to the app. At the end of every week, those who fulfill 3–5 valid PA sessions receive a life time bonus of 2 days and a half that is automatically summed to their countdown.
Game components Player's game goal/objective(s):	To stay alive (i.e., do not let their time countdown to be 0) until the end of the adventure. For this purpose, they have to keep increasing their life time by overcoming formative and physical challenges.
Rules:	<ul style="list-style-type: none"> – All participants start the gamification project with 15 days of life and the time counter will start a countdown. – All participants are divided in districts of six members each. They have to feed themselves (i.e., by performing a formative/learning challenge) at least one time every 21 days, and also to hydrate himself (i.e., by performing challenges that encourage creativity) at least one time every 15 days. – Challenges are bought with time (days). Once someone overcomes a challenge, hi/she receives the proportion of time according to the way the challenge is overcome.
Game mechanic(s):	According to the life time obtained after the realization of the different group and individual's challenges, each district and each participant will be situated in both district and individual classifications. At the end of

(continued)

TABLE 1. (CONTINUED)

Procedures to generalize or transfer what's learned in the game to outside the game:	each month of the adventure, those (groups and individuals) who are in the top 3 of the classification will benefit from a life time bonus. Those participants that obtain the highest score after the realization of a challenge and meet the PA recommendation (i.e., by running or cycling) all in the same week, will level up. Level 1 corresponds to obtaining 1 XP, level 2 to obtaining 2 XP, and level 3 and upper with 3 XP. The XPs can be exchanged for privilege cards, which will facilitate the participants' daylife within the adventure.
Virtual environment	All the learning must be presented in a final innovation project by districts.
Setting (describe):	Also, the participants must encourage the practice of PA of their beloved ones using the "Happiness" section of the app.
Avatar	Not applicable.
Characteristics:	Not applicable.
Abilities:	Not applicable.
Game platform(s) needed to play the game:	[X] Smartphone ☐ Kinect ☐ Xbox™
(check all that apply)	☐ Wii™ ☐ PlayStation [X] Computer ☐ Handheld device ☐ Other:
Sensors used:	Not applicable.
Estimated play time:	Not applicable.

MMOG, massively multiplayer online game; PA, physical activity.

CRF variable by dividing their difference from the pre-intervention mean by the preintervention SD.

Number of weeks meeting PA recommendations. The number of weeks meeting PA recommendations by running or cycling was also registered over a total of 16 weeks to assess the grade of compromise of the IG participants with

the program. All participants of the IG used the mobile app named Runtastic (www.runtastic.com) for registering their daily PA. This app consists of an online sports community based on free real-time GPS tracking of running, cycling, and so on. The validity of a GPS-enabled app to record exercise distance has been previously demonstrated.²¹ Runtastic is aimed at logging PA and allows recording several data

FIG. 1. Home screen and main menu with the life countdown of the “\$in TIME” app. “\$in Time” sections: “Felicidad” = Happiness; “Trabajo” = Work; “Ambulatorio” = Outpatient setting; “Jugador/a” = Player; “Ocio” = Leisure time; “Préstamos” = Loans; “Alimentación” = Food.

TABLE 2. BASELINE CHARACTERISTICS OF THE COLLEGE STUDENTS

	All (n = 117)	IG (n = 58)	CG (n = 59)	P*
Age	20.1 ± 2.9	20.2 ± 3.1	20.0 ± 2.7	0.677
Stages completed in 20mSRT	7.5 ± 1.6	7.3 ± 1.5	7.5 ± 1.7	0.586
Estimated VO ₂ max from 20mSRT	42.9 ± 4.8	42.7 ± 4.5	43.2 ± 5.1	0.586

Values are mean ± SD. *P-value for comparison between groups by one-way analysis of variance. Estimated VO₂max was calculated using Léger's equation for adults.²⁰

20mSRT, 20-meter shuttle run test; CG, control group; IG, intervention group; SD, standard deviation; VO₂max, maximal oxygen consumption.

categories such as covered distance, average speed, pace, and duration of the activity.²² For this study, participants of the IG monitored and registered their daily PA using the Runtastic mobile app. Afterward, they were asked to upload their Runtastic registers into the “\$in TIME” app, specifically into the “Leisure time” section (“Leisure time” is translated as “Ocio” in Spanish, see Fig. 1). Then, the teacher was able to download each participant's PA register from the “\$in TIME” app. Therefore, the number of weeks meeting PA recommendations was computed taking into account the duration of PA performed during a week and the pace of these activities. Particularly, the pace was registered by the teacher to have a control over the intensity at which each activity was performed (i.e., running pace should be >10–13.5 minutes/mile and cycling pace should be >10–15.9 miles/h based on previous research).²³ As young adults are requested to meet at least 150 minutes per week of moderate PA or 75 minutes per week of vigorous PA, by checking the pace that the participants registered using the Runtastic app and applying the previously mentioned cut points, the teacher could have a control over the intensity at which the participants were doing PA. All this was done by the teacher to determine the degree of compromise with respect to the “\$in TIME” program of the participants in the IG.

Statistical analysis

The characteristics of the study sample are presented as means and SDs. The differences in preintervention characteristics between CG and IG groups were analyzed by one-

way analysis of variance. The between-groups intervention effects on raw and z-score CRF levels were studied by one-way analysis of covariance (ANCOVA), inserting stages completed or estimated VO₂max at postintervention as dependent variables, group as fixed factor, and sex, age, and pre-intervention values as covariates. Within-groups analyses were carried out by paired-sample *t*-tests. Cohen's effect size statistics (*d*) as standardized mean differences between groups were also calculated.²⁴ Cohen's *d* values of 0.2, 0.5, and 0.8 were considered small, medium, and large effects, respectively.

An exploratory analysis using ANCOVA was carried out solely in the IG to examine the differences in CRF improvements (i.e., stages or estimated VO₂max at baseline) between clusters of grade of compromise (i.e., participants meeting PA recommendations <100% weeks, *n* = 11; and participants meeting PA recommendations 100% weeks, *n* = 47). A significance level of *P* < 0.05 was set. All the statistical procedures were performed using the SPSS software for Mac (version 20.0; IBM Corporation).

Results

The baseline characteristics of the study sample and the differences at baseline for IG and CG are presented in Table 2. There were no significant baseline differences for age, stages completed in 20mSRT, and estimated VO₂max between IG and CG groups (all *P* > 0.05).

Table 3 presents the raw scores and z-transformed CRF outcomes (i.e., stages completed in 20mSRT and estimated

TABLE 3. EFFECTS OF THE \$IN TIME INTERVENTION ON RAW AND Z-TRANSFORMED POSTINTERVENTION CARDIORESPIRATORY FITNESS (N = 117)

	Mean (95% CI)			P
	IG (n = 58)*	CG (n = 59)*	Difference between groups	
Stages completed in 20mSRT				
Raw score	8.8 (8.7 to 9.0)	7.6 (7.4 to 7.8)	1.2 (1.0 to 1.5)	<0.001
z-Score	0.88 (0.77 to 0.99)	0.10 (−0.01 to 0.21)	0.78 (0.62 to 0.94)	
Estimated VO ₂ max [mL/(kg/min)] in 20mSRT				
Raw score	47.2 (46.7 to 47.8)	43.4 (42.9 to 44.0)	3.8 (3.0 to 4.5)	<0.001
z-Score	0.88 (0.77 to 0.99)	0.10 (−0.01 to 0.21)	0.78 (0.62 to 0.94)	

z-Score values indicate how many SDs have the postintervention values changed with respect to the preintervention mean and SD. For example, a 0.86 z-score means that the mean value at postintervention is 0.86 SDs higher than the mean value at preintervention time, indicating a positive change in comparison to preintervention values, with negative values indicating the opposite. Bold font indicates significant difference at *P* < 0.05. Estimated VO₂max was calculated using Léger's equation for adults.

*Adjusted for sex, age, and preintervention values.

CI, confidence interval.

VO₂max), adjusting for sex, age, and preintervention values. The *z*-scores are interpreted as the change from baseline in SDs. The mean raw stages completed in 20mSRT at post-intervention were significantly different between groups ($P < 0.001$, $d = 0.7$), with a mean of 8.8 stages (95% confidence interval [CI], 8.6–9.0 stages) in the IG and a mean of 7.6 stages (95% CI, 7.4–7.81 stages) in the CG after adjustment for sex, age, and raw stages at baseline; mean difference, 1.2 stages (95% CI, 0.9–1.4 stages). Similarly, the mean raw estimated VO₂max in 20mSRT was also significantly different between groups ($P < 0.001$, $d = 0.6$), with the IG having a mean of 47.1 mL/(kg·min) [95% CI, 46.6–47.7 mL/(kg·min)] and the CG having a mean of 43.4 mL/(kg·min) [95% CI, 42.9–44.0 mL/(kg·min)] after adjustment for sex, age, and raw estimated VO₂max at baseline; mean difference, 3.69 mL/(kg·min) [95% CI, 2.89–4.49 mL/(kg·min)]. For the *z*-scores, there was also a significant difference ($P < 0.001$) between IG and CG, with a mean difference of 0.76 (95% CI, 0.59–0.92) for both stages and estimated VO₂max in 20mSRT after adjustment for sex, age, and preintervention *z*-scores.

Exploratory analysis displaying differences in stages completed in 20mSRT at postintervention between different grades of compromise meeting PA recommendations from the IG participants showed a significant difference of 0.7 (95% CI, 0.2–1.2) stages at postintervention between college students meeting PA recommendations 100% of weeks and participants not meeting recommendations 100% of weeks ($P = 0.004$).

Discussion

The main finding of this study suggests that college students participating in the “\$in TIME” gamification program, and using a mobile app to manage their own life time and meet PA recommendations, improved their CRF levels in comparison with peers from the CG. In the IG, we also found significant differences in CRF between those meeting PA recommendations 100% of the weeks and those who did not. Our findings suggest that including a gamification approach for teaching in a university setting (i.e., learning by playing a game-based mobile app) and helping college students to manage their lifetimes may help them improve their CRF.

The rationale for the development of the present study was the lack of time previously detected in the literature as a main barrier for improving CRF levels in college students.^{7,8} Hence, lack of time for having an active lifestyle has been related to lower CRF levels among college students.¹⁰ However, and to the best of our knowledge, no previous studies in an educational setting had focused on promoting teaching strategies (i.e., gamification) to help college students’ time management and lead them to health improvements. In spite of this, mobile apps have been reported as an effective tool to improve physical health and, therefore, several investigations have analyzed the influence of the use of mobile apps on CRF.^{25–27} Particularly in adults, a study testing two different apps (i.e., step app and cardio fitness app) found significant within-group improvements in VO₂max in all groups.²⁷ Another study in adolescents found significant differences between an IG using an app designed to provide motivational messages and fitness challenges and

a CG.²⁶ There is also a growing body of evidence on the effects of programs based on increasing PA practice on CRF in adults that show beneficial effects.^{28,29} Altogether, the evidence from previous research supports the significant differences found in our study between the IG and CG.

A recent meta-analysis and review have indicated that interventions aiming to increase PA levels in adults are only marginally effective and find difficulties in being implemented.^{30,31} In light of this, a factor that appears to be of importance when programming PA and creating adherence to it is motivation.³² In fact, a recent study using a gamification program named “Beat the Streets,” which consisted of registering walking and cycling journeys at strategic points placed on lampposts around the city, showed that participants significantly increased their weekly walking and PA.³³ In that study, participants had to compete to see which schools, communities, and individuals could achieve the greatest PA over the course of the game period.³³ In the context of education, when a gamification approach is carried out as a teaching methodology, the main motivation that students have to regularly attend their lectures is the game atmosphere itself.³² In this study, the gamification technique was used as a motivational teaching tool to encourage college student to practice PA and meet the recommendations the highest possible number of weeks so that they could experience significant CRF improvements as a result. In this context, the “\$in TIME” mobile-based app designed for the study was considered a useful tool for the implementation of gamification. For instance, the app allowed the students to check their lifetime’s countdown and thus make the decision to practice more PA or take on another challenge that allowed them to gain time. Therefore, gamification seems to be a powerful and useful tool to promote behavioral changes leading to healthier lifestyles. Moreover, motivational interventions that promote physical health improvements such as gaming mobile apps should be also tested in other community settings.

A factor that may explain the PA behavioral changes of IG participants toward an increase in their CRF levels could be the implementation of learning activities outside of the academic context. Based on the “In Time” film, the “\$in TIME” program was developed to excite the participants as a result of having to fight against time and living the experience in real life. For this purpose, a mobile-based app was designed so that each participant could see a countdown of their “life.” Only by overcoming learning and PA challenges (i.e., meeting PA recommendations) were they able to gain time and stay alive at the end of the teaching experience. In other contexts, some studies have also used a game-based mobile app to increase PA levels and they showed that app users reported higher PA than nonusers.^{16,17} Further studies are needed to confirm the benefits of gamification in the educational context and more widely in other community settings.

The main limitations of this study were the relatively small sample size, the fact that it was a convenience sample, the lack of information about anthropometric characteristics, and the lack of a valid tool to assess PA levels. On the other hand, to the best of our knowledge, this is the first study investigating the influence of a gamification program using a game-based mobile app on the CRF of college students in a university setting.

Conclusions

A gamification program based on using a game-based mobile app in a university setting had a significant effect on the CRF in college students, in comparison with a CG that followed a traditional teaching methodology. Furthermore, in the IG, those who met the PA recommendations a larger number of weeks had a higher CRF change at postintervention. Our findings suggest that including a gamification approach as a motivational strategy to encourage PA levels can lead to physical health benefits in young adults. Moreover, the use of a game-based mobile app may help to promote active lifestyles and therefore increase CRF.

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