






Impact of a digital serious game on emotional variables of students of the master's degree in teaching

Isaac J. Pérez-López , Carmen Navarro-Mateos  and Jose Mora-Gonzalez 

Department of Physical Education and Sports, Faculty of Sport Sciences, University of Granada, Granada, Spain

ABSTRACT

The training of future teachers requires innovative strategies that involve and motivate students. The aim of this study was to analyse the impact of a digital serious game on students' emotional variables. A total of 62 students aged 22–23 years of age from a Master's degree participated. A digital serious game called 'The case of the stolen exam' was carried out in an experimental group to analyse its impact on emotional variables, in comparison with a control group that did not take part in this serious game. To evaluate several emotional variables, the Gameful Experience in Gamification scale was used, including five dimensions: enjoyment, absorption, creative thinking, activation, and absence of negative effect. Significant differences were observed favourable to the experimental group in all the questionnaire's dimensions with an overall high effect size ($r \geq 0.61$). New innovative approaches in education are needed to improve students' commitment and motivation.

KEYWORDS

Active methodologies; motivation; physical education; serious games

Introduction

Nowadays, young adults are characterised by a rapid capacity to make decisions and be continuously connected, by a preference for the visual content, and by a general concern about the personal image they transmit to society (Daukseviciute, 2016; García-Ruiz et al., 2018). We talk about a first generation born in a world connected globally thanks to the internet, where technology constitutes an important part of its reality and everyday life (Cilliers, 2017; Jawad & Tout, 2021). In addition, the accessibility to platforms such as *Netflix* or *Youtube* (i.e. possible access from different devices), and the use of different applications, facilitates the viewing of any content whenever this generation is interested in it (Shatto et al., 2016). Another aspect to highlight is the daily use of social networks as a means of entertainment and interaction with their nearby environment (Díaz-Chica et al., 2021).

In view of this situation, the educational sector cannot remain static, since it is increasingly necessary to include digital technologies in teaching-learning processes in order to bring them closer to the needs and demands of students (Baranowski &

Odrawaz-Coates, 2018; Medina Ojeda, 2019). The inclusion of digital technologies in education is also oriented to prepare students to succeed in a world of work in which communication, collaboration, fluidity, research, digitisation and technology are a reality (Kostikova et al., 2021; Vahtivuori-Hänninen et al., 2014). Therefore, innovative teaching strategies, that use different approaches to fully involve students, are required to make learning more attractive (Pérez-López et al., 2017; Shatto et al., 2016). In this context, the game-based learning (GBL), i.e. the use of games and video games to improve learning, becomes important (Boyle et al., 2016; Plass et al., 2015). There is increasing evidence of its benefits in the educational field, as they have potential to enhance cognitive processes (Tobias et al., 2014), improve soft skills and executive functions such as inhibitory control, working memory or cognitive flexibility (Diamond, 2013; Kostikova et al., 2021), and maintain attention over longer periods of time. GBL is a fun and interesting approach (Rotgans & Schmidt, 2011) where making a mistake is understood as something natural and part of the process (Kapur & Bielaczyc, 2012) allowing therefore the transfer of all these skills to real contexts (Greitemeyer & Osswald, 2010).

Closely related to the GBL are the serious games, which are games designed for an educational purpose, beyond entertainment (Bellotti et al., 2010; Nazry & Romano, 2017). They are used to improve student learning and the development of different skills and competences in the educational field, by overcoming the different obstacles and challenges offered by the game (Zhonggen, 2019). In fact, they can be a complementary tool for developing skills such as communication, creativity, emotional management, critical thinking or problem solving, all useful to favour the adaption to modern society (Drigas & Karyotaki, 2016; Romero et al., 2015). Different proposals have shown the enormous benefits that serious games can have in higher education, where levels of demotivation are very high (de la Torre et al., 2021; Kazimoglu et al., 2012). In addition, at this stage, professional skills that allow students to face the enormous changes that our society is experiencing must be promoted (del Valle et al., 2022).

In the present study, we present and analyse the impact of a digital serious game, carried out in the Master's degree in teaching (specialisation in Physical Education), on students' levels of enjoyment, absorption, creative thinking, activation and absence of negative effect, in comparison with a control group.

Materials and methods

Study design and participants

We used a quasi-experimental design including two different groups, an experimental group (EG) and a control group (CG), with post-test measures taken three weeks after the educational intervention that was based in a digital serious game experienced by the EG. This design is frequent of situations in which the research is carried out in real contexts with natural groups, as the intention is to maintain the reality of the classroom and its natural conditions (only modified by the intervention throughout the digital serious game).

The sample of this study consisted of a total of 62 graduate students, 32 from the CG (23 boys and 9 girls) and 30 from the EG (19 boys and 11 girls). All of them were enrolled in the academic course 'Learning and Teaching of Physical

Education' during 2020/2021 academic year, belonging to the specific module of the Master's degree in Teaching in Secondary School (Specialisation in Physical Education) of the University of Granada. The purpose of this course was to develop the fundamental competences of a Physical Education teacher, with innovation as the main pillar to improve the educational quality. The main learning outcomes of this course are:

- To know and analyse the curricular elements for Physical Education Secondary Education.
- To know and use the basic concepts of the didactic of Physical Education.
- To plan a school educational programme in Physical Education from a critical perspective.
- To acquire teaching skills for the future development of their professional work.

Serious game-based educational experience

Both the EG and the CG participated in the course entitled 'Learning and Teaching of Physical Education', following the contents stipulated in the syllabus (all of them related to planning, intervening and evaluating in Physical Education). In parallel to this, the EG participated, during non-school hours, in a digital serious game called 'The case of the stolen exam'. Each student belonging to the EG, autonomously and according to their personal learning pace and motivation, was performing the different challenges from the serious game experience.

As students were able to move forward in the game overcoming the challenges that it has for them, they could discover a great diversity of course contents. Among these contents, they could find active methodologies content and key aspects to design a teaching unit, especially those related to different curricular elements and evaluation. All this was developed under the narrative of a case consisting in a stolen exam that they should solve. By overcoming challenges and solving the case, they gained access to different materials related to the contents previously mentioned (books, scientific articles, *Twitter* accounts of teachers who provide valuable materials, etc.).

The idea of the present intervention was taken from the *Twitter* account @CrímenesIlustrados, where an initiative was proposed with a huge impact during the COVID-19 pandemic, as a means of entertainment and disconnection. This account shared illustrations of scenes of different crimes and the followers could find clues, and interact with the objects in the room, until finding the perpetrator and the motive.

Given that social networks are part of the reality of college students and that they employ much of their leisure time using them, we took advantage of this initiative to encourage their involvement in the course, promoting learning processes in digital environments and formats. Therefore, we decided to adapt the initiative of 'Illustrated Crimes' to the educational field, with the name of 'C.S.I.'. (from the Spanish expression 'Crimen Simulado Interactivo' [Interactive Simulated Crime] –winking at the well-known series CSI–), through the design of a digital serious game. In short, the intervention consisted of a training challenge that favoured the acquisition of various teaching contents and competences making the most of the curiosity and motivation generated among the students.



Figure 1. Interactive 'crime scene' that the students received for the serious game-based intervention.

The objective of the digital serious game was to solve 'The case of the stolen exam'. For this purpose, the teacher presented a 'crime scene' to the students, through an image made with *Genially* (Figure 1), which had all the necessary information to solve the case (access the game here: <https://view.genial.ly/5f32510e9a67350d7bac40f2>). Everything revolved around the fact that the teacher (presented lying on the floor in the image – Figure 1) had been the victim of the theft of the exams. In this context, students were invited to collaborate in the research, with a dual objective: i) Identify who from the four suspects (shown in the image in Figure 1) had committed the theft, find out how they had done it and what their motive was for it; ii) Find the exam questions. For this, they had access to the interactive image of *Genially*, which had numerous clues that allowed them to access all the information necessary to solve the case. The students could interact with the different objects in the office, having access to the personal belongings of the suspects and the files with the data collected by the police (Figure 2).

In the different objects that could be seen in the teacher office there was information related to the contents of the course, and the students had the need to investigate and deepen on them to be able to extract relevant information for the case. In fact, there were titles of books related to neuroeducation, active methodologies and the principles necessary to propose innovative proposals in the classroom located on the table that appears in the interactive image of the case. Also, the mobile phone screen located on the books included a photograph of a woman that should be contacted. She was an active teacher who shares in her social networks



Figure 2. Example of a file with the data collected by the police and the personal belongings of one of the suspects.

many resources and ideas that could be useful for students. In addition, various tools and applications such as *Genially*, *Canva* and *Lockee* were used for the development of the digital serious game, which allowed students not only to discover them, but at the same time to experience their possibilities as future Physical Education teachers.

Dependent variables

To analyse the impact of the digital serious game ‘The case of the stolen exam’, the GAMEX (Gameful Experience in Gamification) scale, or gamified experience evaluation scale, was used to know the students’ perception about the different dimensions that this scale included. The scale was developed and validated in English (Eppmann et al., 2018), and its reliability as a tool for collecting information in gamified experiences has been demonstrated. Particularly, the reliability of the questionnaire in the present sample showed a Cronbach’s Alpha >0.9 for each dimension. For the present study, the validated Spanish version was used (Parra González & Segura Robles, 2019). The answer options were Likert type (1 = ‘totally disagree’ and 5 = ‘totally agree’). The scale comprised five main dimensions around the experience of participants in gamified environments: enjoyment (composed of six items and assessed the degree of the student’s enjoyment with the experience), absorption (composed of six items and assessed the degree of absorption in the experience and evasion of the environment), creative thinking (composed of seven items, this dimension analysed the degree of creativity that the student perceives that develops during the experience, and the confidence that the student has in himself during it), activation (consisted of three items and measured the degree of activity that the student considers that has developed during the experience), and absence of

negative effect (formed by three items and analysed if students felt negative emotions while playing, such as frustration).

Statistical analysis

Descriptive characteristics of the sample and the GAMEX questionnaire are presented as means and standard deviations for each variable. The normality of the variables was tested using the Kolmogorov–Smirnov test and the visual inspection of histograms.

We first checked and confirmed that the dependent variables (dimensions of the GAMEX questionnaire) showed skewed distribution, i.e. did not follow a normal distribution, as well as the heterogeneity of the variances. Following previous evidence (López-Belmonte et al., 2020), we used the Mann-Whitney U statistical analysis, for non-parametric statistics (Vickers, 2005), to test the main objective of the study, that was, whether there were significant differences in the dimensions of the GAMEX questionnaire between the EG and the CG. The effect size of the significant differences was also computed through the Mann-Whitney U test (r), which captures the standardised median difference between the two groups and whose effect size classification is: 0.1 (small effect), 0.3 (moderate effect) and 0.5 and above (large effect). All analyses were performed using IBM SPSS-25, and the significant level was set at a $p < 0.05$.

Results

The comparison between the EG and the CG with respect to the dimensions of the GAMEX questionnaire is shown in Table 1.

Significant differences were found between both groups for all dimensions of the GAMEX questionnaire. Specifically, our findings suggest that living a digital serious game experience has a significant impact on students' perception, compared to that of CG, of enjoyment ($Z = -6.873$, $p < 0.001$), absorption ($Z = -6.804$, $p < 0.001$), creative thinking ($Z = -6.845$, $p < 0.001$), activation ($Z = -6.896$, $p < 0.001$) and absence of negative effect ($Z = -4.839$, $p < 0.001$). It should be noted that, for all positive dimensions (i.e. except for absence of negative effect), the scores obtained by the EG (Mean rank = 47.50) were significantly superior than the scores obtained by the CG (Mean rank = 16.50). Considering the effect size of the significant differences between groups, all were considered high

Table 1. Differences in Gameful Experience in Gamification (GAMEX) questionnaire dimensions between the experimental and control group (Mann-Whitney U test).

GAMEX dimensions	Groups	Mean (SD)	Median (IR)	MR	Z	r	p
Enjoyment	Experimental	4.71 (0.36)	4.83 (0.50)	47.50	-6.873	0.87	<0.001
	Control	2.81 (0.25)	3.00 (0.33)	16.50			
Absorption	Experimental	4.56 (0.42)	4.67 (0.67)	47.48	-6.804	0.86	<0.001
	Control	2.77 (0.22)	2.83 (0.29)	16.52			
Creative thinking	Experimental	4.39 (0.44)	4.43 (0.71)	47.50	-6.845	0.87	<0.001
	Control	2.77 (0.18)	2.86 (0.14)	16.50			
Activation	Experimental	4.50 (0.60)	4.83 (1.00)	47.50	-6.896	0.88	<0.001
	Control	2.76 (0.31)	3.00 (0.33)	16.50			
Absence of negative effect	Experimental	2.30 (0.65)	2.33 (1.00)	20.20	-4.839	0.61	<0.001
	Control	3.20 (0.55)	3.00 (0.33)	42.09			

SD = Standard deviation; IR = Interquartile range; MR = Mean rank.

(above $r = 0.5$). The highest effect size was found for the activation dimension ($r = 0.88$), followed by the enjoyment and creative thinking dimensions (both $r = 0.87$). The smallest effect size, but still considered high, was seen for the absence of negative effect dimension ($r = 0.61$).

With respect to the individual scores of the items that make up each of the five dimensions, and particularly for the dimension of enjoyment, the EG reported a score greater than 4 points for all enjoyment items (mean score = 4.71 ± 0.36 -Table 1, Figure 3), highlighting item E-2 ('I liked playing' = 4.80 ± 0.41). In contrast, the CG obtained an average score for enjoyment of less than 3 points (mean score = 2.81 ± 0.25). Similarly, the EG reported scores above 4 points for absorption dimension items, highlighting item AB-3 ('After playing I felt like returning to the real world after a trip' = 4.73 ± 0.45), followed by item AB-2 ('I forgot about my immediate environment while playing' = 4.63 ± 0.62). However, the CG's average value for absorption dimension did not exceed 3 points (mean score = 2.77 ± 0.22). The EG also reported responses above 4 points for all items in the creative thinking dimension, while in the CG none of them reached 3 points. In the aforementioned dimension, it is important to highlight the value obtained for the item C-1 by the EG ('Playing aroused my imagination' = 4.67 ± 0.55) and item C-2 ('While playing I felt creative' = 4.53 ± 0.57). Activation dimension items were also reported with scores above 4 points by the EG and below 3 points by the CG. It is worth mentioning in the EG the item AC-3 ('While playing I felt excited' = 4.73 ± 0.52).

Finally, in reference to the absence of negative effect dimension, the group that experienced the serious game reported scores below 3 for all items, highlighting the low score of item AS-2 ('While playing I felt hostile' = 1.80 ± 0.66). In contrast, the CG reported a mean score over 3 points for all items of this dimension, being item AS-3 ('While playing I felt frustrated') the one that received the highest score (mean score = 3.31 ± 0.59).

Therefore, all items answered by the EG were reported with very high values, since the maximum possible value to answer was 5, and all items (except those of the absence of negative effect dimension that is interpreted in opposite way) were answered above 4. In contrast, in the CG all items were below 3 points, except those referred to absence of negative effect.

Discussion

The main aim of this study was to analyse the impact of a digital serious game on the levels of enjoyment, absorption, creative thinking, activation and absence of negative effect that the game itself propitiated in the participating students, compared to a CG.

The findings from this work reveal the positive impact of the digital serious game on future teachers' aspects as relevant as creative thinking or the activation of students during their development, thus increasing their motivation. Different systematic reviews and meta-analyses support this circumstance, highlighting that its proper implementation leads to an improvement in the acquisition of learning and the development of different soft skills (Boyle et al., 2016; Papoutsis et al., 2022; Zhonggen, 2019).

However, despite the boom that this type of proposal is currently reaching (Papoutsis et al., 2022) the type of games that affected the development of emotional skills in the educational field have been mainly focused on young adolescents (Cejudo et al., 2019; DeRosier &

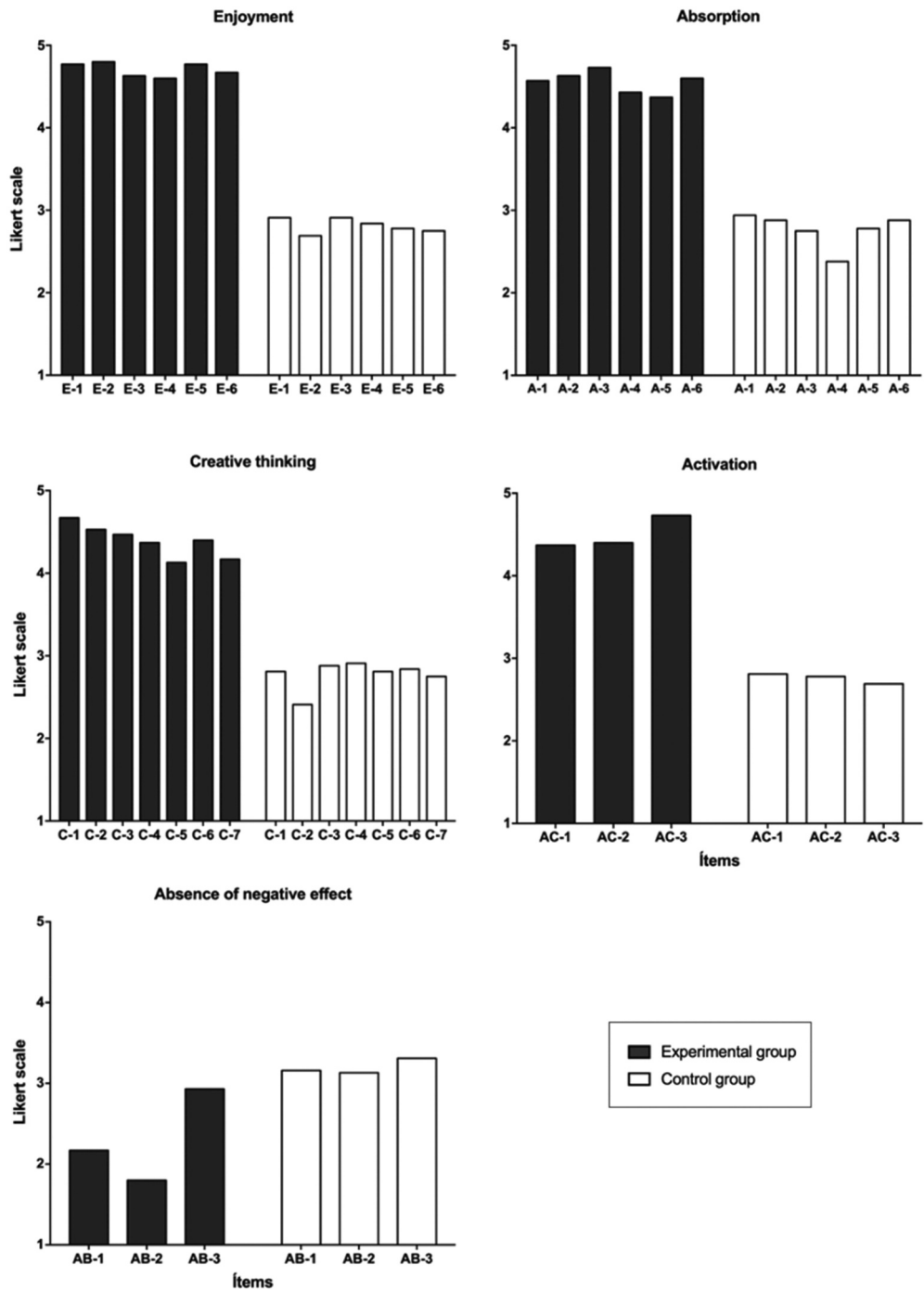


Figure 3. Bar distribution of the Likert-based punctuation for each item classified by dimensions of the GAMEX (Gameful Experience in Gamification) scale. E-1: 'Playing the game was fun', E-2: 'I liked playing the game', E-3: 'I enjoyed playing the game very much', E-4: 'My game experience was pleasurable', E-5: 'I think playing the game is very entertaining', E-6: 'I would play this game for its own sake, not only when being asked to'. A-1: 'Playing the game made me forget where I am', A-2: 'I forgot about my immediate surroundings while I played the game', A-3: 'After playing the game, I felt like coming back

Thomas, 2019; Ferreira et al., 2021) or in Primary school children (Koivula et al., 2017). Therefore, it was of importance to expand this field over, for example, higher education. Moreover, in a review, games related to science, technology, engineering and mathematics (STEM) were the most popular, followed by those related to health (Boyle et al., 2016). This idea was supported by the results of another review since it highlighted that serious games have been applied in the context of teaching medicine due to their positive effects on the learning and participation of the students (Zhonggen, 2019). Therefore, its implementation in the training of future teachers, as in the presented scenario (in the Master's degree in teaching) remains insufficiently explored, which justifies the relevance of this work.

The results obtained are positive, since the scores achieved in all dimensions of the GAMEX questionnaire, except in the absence of a negative effect dimension, are very high (above 4, being 5 the maximum). In fact, the differences in the dimensions of enjoyment, absorption, creative thinking, and activation are highly significant between the EG and the CG. In addition, there is evidence that, through enjoyment, abstraction and the absence of negative effect (or its corresponding management), creative thinking is increased (Parra González et al., 2020).

These results are in line with other proposals carried out in higher education. Two of them focused on the use of escape rooms to work with nursing-related contents (Anguas-Gracia et al., 2021; Antón-Solanas et al., 2022). They obtained mean scores above 3 in the dimensions discussed above, demonstrating that the game increased students' motivation towards learning. With regard to the Master's degree in teaching, two proposals must be highlighted in which the use of technology also had a special role. One of them consisted of an escape room inspired by the saga of *The Matrix* (Navarro Mateos & Pérez-López, 2022). Among the results obtained in this work, we highlight that the average score for the absorption and activation dimensions was higher than 4.5, showing the potential of this approach to work with specific contents and teaching competencies. The other intervention compared the impact of a face-to-face proposal to a digital one and showed that, in virtual environments, the autonomy, creativity and freedom to discover were increased among students (Sánchez et al., 2022).

Finally, with regard to the absence of negative effect, it is evident that in approaches like the one developed in the present study, high levels of frustration may appear. This circumstance, however, is particularly interesting in the case of students from the Master's degree in teaching (future teachers), given the formative value of a learning context where their emotional management and resilience are tested (Anguas-Gracia et al., 2021; Navarro Mateos & Pérez-López, 2022). In fact, as with other educational tools, it is important to analyse how the game is integrated

to the "real world" after a journey', A-4: 'Playing the game "got me away from it all"', A-5: 'While playing the game I was completely oblivious to everything around me', A-6: 'While playing the game I lost track of time'. C-1: 'Playing the game sparked my imagination', C-2: 'While playing the game I felt creative', C-3: 'While playing the game I felt that I could explore things', C-4: 'While playing the game I felt adventurous', C-5: 'While playing the game I felt influential', C-6: 'While playing the game I felt autonomous', C-7: 'While playing the game I felt confident'. AC-1: 'While playing the game I felt jittery', AC-2: 'While playing the game I felt frenzied', AC-3: 'While playing the game I felt excited'. AB-1: 'While playing the game I felt upset', AB-2: 'While playing the game I felt hostile', AB-3: 'While playing the game I felt frustrated'.

into the learning experience to have an impact at the cognitive, affective and behavioural level (Lamb et al., 2018).

Several limitations must be acknowledged from the present study. First, the natural randomisation of participants was hampered by the quasi-experimental design of the study. Therefore, students chose themselves one of the two groups before the study commenced, and they could not be randomised. Second, while the questions in the GAMEX questionnaire mainly focus on the impact of gaming on students' emotions, the CG group did not participate in any gaming activities, and so their responses may be influenced by this fact. Third, the statistical power may be limited by the relative sample size. Despite these limitations, some several strengths must be recognised. To the best of our knowledge, this is the first study investigating the impact of a digital serious game on students' emotions. Other strengths include the standardised assessment for students' emotions.

Conclusion

An educational intervention, based on the implementation of a digital serious game, significantly improves the levels of enjoyment, absorption, creative thinking, activation, and absence of negative effects among students from the Master's degree in teaching, in comparison with a CG. Therefore, the need to adopt new approaches that incorporate technology in educational interventions acquires special relevance in today's society. Further, approaches that favour the involvement and motivation of students towards their learning process are needed in order to improve their commitment and the levels of significance of learning.

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Notes on contributors

Isaac J. Pérez-López Professor in the Department of Physical Education and Sports (Faculty of Sport Sciences, University of Granada). Main lines of research: Play, gamification and learning, teaching innovation, intervention programmes for the promotion of healthy lifestyles and analysis of physical education.

Carmen Navarro-Mateos Graduated in Sports Sciences. Master of Teaching and Research in Physical Activity and Sport. Master's in Gamification and Transmedia Narrative. PhD in Education Sciences.

My line of research is the analysis of the potential of active methodologies and recreational options in higher education.

Jose Mora-Gonzalez Assistant Professor in the Department of Physical Education and Sports (Faculty of Sport Sciences, University of Granada). Main lines of research: Effect of gamification on several health variables in higher education; Effect of exercise and physical activity for health.

ORCID

Isaac J. Pérez-López  <http://orcid.org/0000-0002-4156-7762>

Carmen Navarro-Mateos  <http://orcid.org/0000-0002-0757-7975>

Jose Mora-Gonzalez  <http://orcid.org/0000-0003-2346-8776>

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