JOURNAL OF NEW APPROACHES IN EDUCATIONAL RESEARCH
2022, VOL. 11, NO. 2, 307-322, e-ISSN: 2254-7339
https://doi.org/10.7821/naer.2022.7.1025

ORIGINAL

Comparing Gamification Models in Higher Education Using Face-to-Face and Virtual Escape Rooms

Santiago Pozo-Sánchez[1], Georgios Lampropoulos[2] and Jesús López-Belmonte[3]

[1]Department of Research Methods and Diagnosis in Education, University of Granada, Spain
[2]Department of Information and Electronic Engineering, International Hellenic University, Greece
[3]Department of Didactic and School Organization, University of Granada, Spain

ABSTRACT

Gamification is a training model that encourages the inclusion of active methodologies into learning environments. The objective of this study is to analyze the effects of a gamified experience through virtual and face-to-face escape rooms as well as to determine the generated levels of fun, absorption, creative thinking, mastery, activation, absence of negative effects and student grades. A descriptive and correlational experimental design has been used. In total, 105 Spanish university students participated. The data was collected using a scale validated in the Spanish context called Gameful Experience in Gamification (GAMEX). The results reveal significant variability according to the training environment. In face-to-face environments, students' fun and activation were promoted, generating pleasant entertainment experiences. In virtual environments, influence, autonomy, creativity, and exploration by students increased. Similarly, these environments shared high levels of spatio-temporal absorption and an absence of negative effects. Regarding the ratings, no statistically significant results that confirm their effectiveness depending on the environment were determined, but good scores were obtained. It is concluded that the choice of the gamified environment will depend on the dimensions and the goals that the teacher intends to achieve during the learning process.

Keywords EDUCATIONAL INNOVATION, TEACHING METHOD, GAMIFICATION, HIGHER EDUCATION, EDUCATIONAL TECHNOLOGY

Received 2022-01-10
Revised 2022-01-19
Accepted 2022-04-08
Published 2022-07-15

Corresponding Author
Santiago Pozo-SánchezJesús López-Belmonte,
josesantiago.pozo@unir.net

Facultad de Educación, Economía y Tecnología de Ceuta, C/ Cortadura del Valle S.N., 51001 Ceuta, Spain.

DOI https://doi.org/10.7821/naer.2022.7.1025
Pages: 307-322

1 INTRODUCTION

As students grow up in a digitalized world and handle dynamic and interactive digital information in real time, their way of learning and their concept of an effective educational environment have significantly changed. Although both teacher-centered and, to a lesser extent, student-centered approaches are being used, students are now more than ever seeking to actively participate and be involved in teaching and learning activities and not simply to listen passively (Anastasiadis, Lampropoulos, & Siakas, 2018; Gudmundsdottir, Hernández,

Colomer, & Hatlevik, 2020). More emphasis is being put on comprehending how teachers and students interchangeably teach and learn as well as on adopting and implementing active methodologies and innovative approaches so as to enhance students' engagement, motivation and development within the educational sector (Rossi et al., 2021).

Active methodologies aim at not only enhancing students' active participation and involvement but also at creating student-centered environments which promote meaningful and in-depth learning and can assist in turning students into active agents of their own education and learning tasks (Vanduhe, Nat, & Hasan, 2020). Recent studies have highlighted the benefits that the implementation of active methodologies in education can yield, such as students' increased motivation, engagement, soft skills and academic performance (Murillo-Zamorano, Sánchez, Godoy-Caballero, & Muñoz, 2021; Zainuddin, Chu, Shujahat, & Perera, 2020). It is worth noting that due to their nature, active methodologies can be used in conjunction with a variety of approaches and technologies and can be applied in a wide range of educational levels and fields. Specifically, the use of game mechanics and gaming in general promotes the creation of playful and interactive learning environments which enhance conscious engagement (Wang, 2015).

Gamification supports and builds upon the fundamentals of active methodologies and game mechanics and can be used to enhance students' learning experience, involvement and performance (Bai, Hew, & Huang, 2020; Cechetti et al., 2019). Specifically, gamification refers to "*the use of game design elements in non-game contexts*" (Deterding et al., 2011, p. 9). Moreover, the use of escape rooms as educational tools is becoming more popular as they are in line with the principles and concepts of gamification, play theory and active methodologies. In escape rooms, participants are locked in a specific physical or virtual space and by individually or collaboratively self-managing their knowledge and finding clues to solve puzzles, riddles, enigmas or meet general challenges, they aim to accomplish specific goals within a set amount of time (Nicholson, 2018; Pitoyo, Sumardi, & Asib, 2020). It is worth noting that gamification and escape rooms can be used in both physical and digital environments. Furthermore, as they share common attributes and goals, they can be used in combination to further improve educational outcomes.

As gamification constitutes a novel way to enhance human engagement, its application in education is gaining in popularity as it positively affects the educational sector, in which the support and retention of students' engagement and motivation is essential (Hamari, Koivisto, & Sarsa, 2014; Majuri, Koivisto, & Hamari, 2018). By applying game mechanics and game design elements within an educational context, the overall learning experience becomes more enjoyable and intriguing (Anastasiadis et al., 2018), students' engagement and involvement are increased (Bouchrika et al., 2019) and, simultaneously, students' academic performance and learning outcomes are improved (Barna & Fodor, 2017; Yildirim, 2017). Moreover, gamification has the potential to bring about positive psychological and behavioural changes (Kim, Song, Lockee, & Burton, 2017) and to affect both learners' intrinsic and extrinsic motivations (Dicheva, Dichev, Agre, & Angelova, 2015; Roy, Van, & Zaman, 2018), which is a vital factor as it is directly linked to academic success (Wigfield, Faust, Cambria, & Eccles, 2019).

Escape rooms, which foster the attributes of gamification, are applied at all educational levels in both physical and digital learning environments with positive outcomes (Veldkamp et al., 2020). Although escape rooms in physical environments might provide increased opportunities to collaborate and interact more actively in comparison to digital ones (Ang, Ng, & Liew, 2020), in both cases there are benefits that can be yielded when applied in educational settings in a student-centered manner (Morrell & Ball, 2019). Specifically, they can affect students' cognitive, affective and behavioural domains (Chou, Chang, & Hsieh, 2020), increase their engagement and learning experience (Lopez-Pernas, Gordillo, Barra, & Quemada, 2019), provide them with a sense of accomplishment (Vidergor, 2021) and improve their motivation, knowledge and teamwork (Prieto, Jeong, & Gómez, 2021). Students are more interested in playful, interactive and enjoyable learning activities, as is the case with escape rooms, when compared with traditional teaching sessions (Neumann, Alvarado-Albertorio, & Ramírez-Salgado, 2020).

When combining gamification with escape rooms, more interactive and engaging learning experiences can be created. These gamified escape rooms can provide learners with low-cost, secure and high-impact learning environments (Guckian, Eveson, & May, 2020) in which learners can hone their team-building and soft skills (Parker & Welch, 2021) and significantly improve their autonomy, motivation, anxiety management and academic performance (Brady & Andersen, 2021). Moreover, students that experience learning through gamified escape rooms, which encourage the absence of negative effects, demonstrate better teamwork, absorption and commitment as they actively engage themselves in learning and teaching processes (Cohen et al., 2020). By designing appropriate and thought-provoking challenges for learners to solve individually or collaboratively, meaningful learning can be achieved (Moura & Santos, 2019) .

As educational needs constantly alter, there is a drastic need to meet these requirements by adopting new approaches and incorporating technology into education (Gudmundsdottir et al., 2020). Moreover, it is particularly important to actively involve students in the educational process (Rossi et al., 2021). It is vital to adopt active methodologies which not only increase students' engagement but also provide learning experiences that promote meaningful learning, increase students' motivation and enhance their academic performance (Vanduhe et al., 2020). Due to their nature, active methodologies can be successfully combined with approaches that foster play theory and utilize game mechanics (Wang, 2015; Zainuddin et al., 2020). As a result, gamification can be used as an effective method to attract students' attention and interest in actively participating in the learning and teaching process and increase both their intrinsic and extrinsic motivations, thus rendering the overall learning experience more entertaining and interesting while also leading to more positive behavioural attitudes (Bouchrika, Harrati, Wanick, & Wills, 2019; Roy et al., 2018). Furthermore, gamification can be used in conjunction with escape rooms to create more interactive, thought-provoking and playful learning environments that provide a sense of accomplishment and allow critical thinking and collaboration to flourish (Brady & Andersen, 2021; Guckian et al., 2020). These environments can take place both in the real world and the virtual one while simultaneously encouraging the absence of negative effects (Cohen

et al., 2020).

1.1 Justification and Objectives

Nowadays, education faces a process of methodological transformation (Kolster, 2021). This situation is mainly due to various factors. The incidence of technology has meant a great change in the manner of interaction between educational agents and those with didactic content (An & Oliver, 2021). Along these lines, students present interests that are different from those of previous eras (Galán, Lázaro-Pérez, & Martínez-López, 2021). This in turn has triggered new training methods and models to transmit information and generate knowledge (Mengual-Andrés, López-Belmonte, Fuentes-Cabrera, & Pozo-Sánchez, 2020), as is the case with gamification (Putz, Hofbauer, & Treiblmaier, 2020). These changes have allowed students to play an active and learning role in the teaching and learning process (Roig-Vila, Padrón, & Urrea-Solano, 2021). However, within this transformation, Covid-19 has been an aspect that has also altered the traditional canons of training action (García-Peñalvo & Corell, 2020). This pandemic has revolutionized the educational system by modifying training scenarios. It has forced the transition from traditional face-to-face teaching to digital teaching (Iivari, Sharma, & Ventä-Olkkonen, 2020), with the lack of resources and digital competence of the different participants involved being one of its main drawbacks (Heidari, Mehrvarz, Marzooghi, & Stoyanov, 2021).

This situation that is impacting today's education has generated uncertainty in the teaching and research community about the projection and effectiveness of training actions in different settings (Hung et al., 2021). For this reason, this study analyzes the application of a gamified experience, both in face-to-face and digital environments, with the aim of identifying and comprehending the scope of gamification in various dimensions depending on the environment in which it is carried out. This research will contribute to answering the various questions posed below. In the same way, which environment is more conducive to carrying out gamified didactic activities will be revealed. The study dimensions selected in this research have been determined by the scientific literature based on intrinsic factors of gamification (Parra & Segura, 2019).

The research questions that this specific study aims to answer are the following:

- RQ1: Does the type of gamified educational environment influence students' fun?
- RQ2: Does the type of gamified educational environment influence students' absorption?
- RQ3: Does the type of gamified educational environment influence creative thinking and student mastery?
- RQ4: Does the type of gamified educational environment influence students' activation?
- RQ5: Does the type of gamified educational environment influence the absence of a negative effect on students?
- RQ6: Does the type of gamified educational environment influence the learning results achieved by students?

2 MATERIAL AND METHODS

2.1 Research Design and Data Analysis

This study followed a quantitative research methodology, focused on a descriptive and correlational experimental design. For optimal development, the considerations formulated by experts in this type of study were taken into account (Hernández, Fernández, & Baptista, 2014). Two groups of analyses were set up. On the one hand, a control group that developed a face-to-face gamified experience was established. On the other hand, an experimental group that carried out gamification telematically using digital applications was delimited.

The collected data was analyzed in depth using the Statistical Package for the Social Sciences (SPSS). In the data analysis, various basic statistical analyses were performed (mean-M; standard deviation-SD), in addition to other coefficients to delimit the trend of the sampling distribution (asymmetry: As; kurtosis: β_2). Finally, a t-test was used to compare the means between the established groups. Cohen's d and biserial correlation (r) was performed to obtain the effect size.

2.2 Participants

A total of 105 Spanish Higher Education students participated in the study. Of these subjects, 30.5% were men and the rest were women, with a mean age of 26 years (SD = 2.61). These students were chosen through non-probabilistic and intentional sampling. The justification for this selection focuses on the fact that the researchers themselves have taken their students as study subjects. The sample size, as has been shown in other impact studies, does not imply a bias in this type of study (Chou & Feng, 2019; Yılmaz & Soyer, 2018).

2.3 Instrument

For data collection, an instrument called the Gameful Experience in Gamification scale (GAMEX) which has been validated in the Spanish context and in the university population (Parra & Segura, 2019) was used. The questionnaire was made up of 27 items catalogued in five dimensions. The Fun dimension (six items) covered the level of enjoyment of the student in the activity. The Absorption dimension (six items) analyzed the degree of avoidance of the student in the gamified experience. The Creative Thinking and Mastery dimension (eight items) took into account students' level of creativity and sense of control. The Activation dimension (four items) analyzed the degree of involvement of the student in the gamified task. Finally, the dimension Absence of negative effect (three items) measured the existence of negative feelings or level of frustration of the student. The instrument follows a five-point Likert scale response format (one being the most negative option and five the most positive).

The students gave the researchers their consent to use their data. A document was signed specifying that the data would be processed anonymously, for scientific purposes and following the principles of Organic Law 3/2018, on the Protection of Personal Data and the guarantee of digital rights.

This instrument has adequate psychometric properties, which are revealed in its validation and reliability process. For its validation, an exploratory factor analysis with promax rotation was used. In the Kaiser-Meyer-Olkin test, a determining value was obtained (KMO = 0.905) as it was in the Bartlett test of sphericity ($\chi 2$ (351) = 4495.775, $p < 0.001$). Similarly, the reliability of the instrument was relevant, obtaining a high Cronbach's alpha value (α = 0.93). The composite reliability was calculated, reaching values above 0.80. It was found that the mean variance extracted had figures greater than 0.53. These results demonstrate the tool to be a valid and reliable instrument to measure all gamified didactic experience in a Spanish university context.

2.4 Procedure

Two gamified experiences were designed for Higher Education. Specifically, these were for students of the Master's degree for teachers of Compulsory Secondary Education, Baccalaureate, Professional Training and language teaching. The experiences covered the same contents (levels of curricular concretion, elements of the didactic programming and attention to diversity) and were divided into four sessions. The only difference was the formative learning environment. One was face-to-face in the classroom while the other experience was carried out virtually using the Genially application. In the face-to-face experience, the students formed different groups and had to face several missions in an escape room (Figure 1).

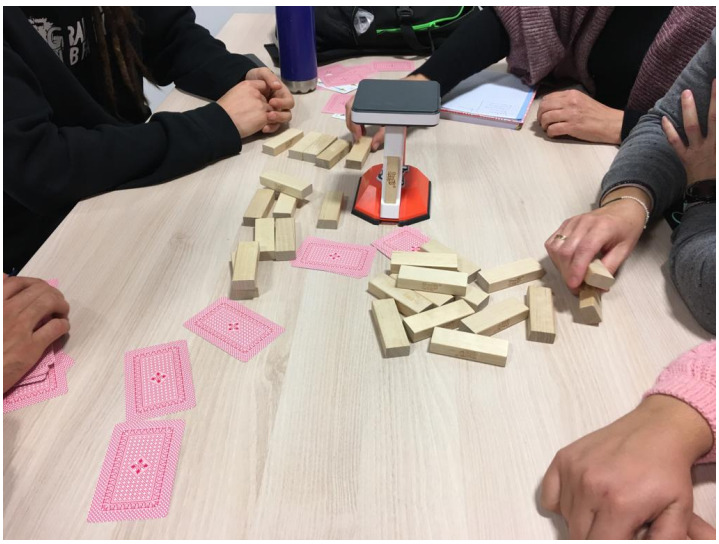

Figure 1 Face-to-face escape room missions

The activity aimed at enabling students to reach the solution and be able to leave the classroom. The same happened with the experimental group but through a digital escape room (Figure 2).

The same challenges arose in both experiments. The only difference was the learning environment in which the students found themselves. For the content related to the levels

Figure 2 Digital escape room interface

of curricular specification, the students had to build a four-level tower of cards and discover what each level referred to. Hence, they could rely on training resources that the teacher had previously established. To work on content related to didactic programming, the students had to play Jenga and find out what relationship this traditional game had with the different elements of didactic programming. Finally, to work on the contents of attention to diversity, the students played the game called Who's Who. As in previous challenges, the students had to find out about the transfer of this game to the reality of the training process in learning spaces. In both contexts, each time a group of students passed a test, challenge, or mission, they earned a badge. The prize object received in the face-to-face context was a sticker and in the virtual context it was a message with an attached image that replicated a medal).

Each badge obtained contained a code within the congratulatory message. A number that the students had to recognize, and which would be useful to them later on, was within the received message. The code of each insignia would allow students to obtain the final word which would enable them to escape from the place. To discover the escape word, they had to enter each of the codes in a hidden tool (in the face-to-face context it was in a place in the classroom and in the virtual context among the training documents uploaded to the institutional platform of the university). This tool was a Caesar cipher, a tool that they themselves had to find out how to use and how they could add the codes to decipher the final code.

At the end of the training sessions, the questionnaire was given to students to collect their viewpoints. In this instrument, the informed consent of the participants was also collected. The learning results achieved by the students in the unit taught in both training modalities were taken into account. This information was provided by the teacher in charge of teaching the content. Subsequently, the data was imported into the statistical program in order to answer the questions raised and establish pertinent conclusions for the scientific community.

2.5 Limitations

Several limitations have been observed in the present study. The first limitation is that the experiments were carried out in a group of students enrolled in a Master's degree on a university campus in a city in Spain. This study focuses on a very specific context. The second limitation occurs in the activities or tests designed for each escape room mission. That is, the design and choice of other tasks could lead to a change in the students' viewpoints in each of the dimensions analyzed

3 RESULTS

The analysis of the parametric results obtained in the control group (Table 1) and in the experimental group (Table 2) reflects variability in the different study dimensions.

In the control group, which carried out face-to-face gamification, positive results are observed in the Enjoyment and Activation dimensions. The scores reflected in these variables are above the central value of the Likert scale ($M \approx 3.7$). The control group recorded especially high values in the variable related to the pleasant experience of the game and the high degree of perceived activity.

The Absorption dimension reflects slightly higher mean values than the central value of the Likert scale. Compared with the rest of the variables, a particularly high value is observed in the variable related to the loss of the notion of time during the game.

In the Creative thinking and mastery dimension, the mean is practically at the central value of the Likert scale ($M \approx 3.00$). However, higher values are observed in the variables related to creativity, exploration and imagination than in the variables related to mastery (leadership, autonomy and influence).

As for the dimension Absence of negative effect, it reflects equally positive values as the arithmetic mean is very close to the first point of the Likert scale, which reflects the lowest value.

To finalize the parametric analysis of the control group, the ratings obtained are addressed. The didactic unit that articulates the research experience was weighted from 0 to 10, from lowest to highest respectively. The average of grades obtained during the face-to-face gamification by the control group reflects a positive result ($M \approx 7/10$).

In the experimental group, which carried out virtual gamification, especially positive results are observed in the Creative thinking and mastery dimension. The scores reflected in these variables are above the central value of the Likert scale and close to the upper value. In a similar way to the face-to-face gamification, slightly lower values are observed in the variables related to leadership, autonomy and influence compared to the variables related to creativity, exploration and imagination.

As for the Absorption dimension, it also reflects slightly higher mean values than the central value of the Likert scale. Compared with the rest of the variables, a particularly high value is observed in the variable related to the loss of the notion of time during the game.

The mean of the Enjoyment dimension is practically at the central value of the Likert scale. Despite this, the variable related to students' option to play the game again without

Table 1 Parametric analysis of the results reported by the control group

Dimensions and variables	M	ST	As	β^2
Enjoyment	3.69	1.12	2.42	-0.42
Enj1- Playing was fun	3.71	1.2	2.26	-0.54
Enj 2- I liked playing	3.69	1.14	2.37	-0.2
Enj 3- I really enjoyed playing	3.71	1.2	2.26	-0.54
Enj 4- My experience with the game was pleasant	3.85	1.01	2.83	0.66
Enj 5- I think playing was very entertaining	3.71	1.2	2.26	-0.54
Enj 6- I would play this game by myself even if not asked	3.52	0.99	2.54	-0.05
Absorption	3.17	1.14	1.92	-0.45
Ab1- Playing made me forget where I was	3.01	1.18	1.7	-0.71
Ab2- I forgot my immediate surroundings while playing	3.01	1.18	1.7	-0.71
Ab3- After playing I felt like going back to the real world	3.15	1.1	1.96	-0.41
Ab4- Playing "took me away from everything"	3.13	1.09	1.95	-0.37
Ab5- While playing I was oblivious to my surroundings	3.01	1.18	1.7	-0.71
Ab6- While playing I lost track of time	3.69	1.08	2.48	0.18
Creative thinking and mastery	3.01	1.17	1.73	-0.69
Ctm1- Playing sparked my imagination	3.19	1.13	1.94	-0.59
Ctm2- While playing I felt creative	3.17	1.12	1.94	-0.57
Ctm3- While playing I felt like I could explore things	3.19	1.13	1.94	-0.59
Ctm4- While playing I felt adventurous	3.19	1.13	1.94	-0.59
Ctm5- While playing I felt I was in command	2.71	1.23	1.39	-0.89
Ctm6- While playing I felt influential	2.63	1.24	1.32	-0.85
Ctm7- Playing sparked my imagination	2.94	1.18	1.64	-0.76
Activation	3.68	1.17	2.28	-0.43
Act1- While playing I felt active	3.69	1.15	2.34	-0.28
Act2- While playing I felt nervous	3.65	1.16	2.29	-0.42
Act3- While playing I felt frantic	3.52	1.18	2.13	-0.78
Act4- While playing I felt excited	3.85	1.2	2.37	-0.26
Absence of negative affect	1.3	0.56	0.54	1.61
Abn1- While playing I felt annoyed	1.37	0.59	0.62	0.58
Abn2- While playing I felt hostile	1.23	0.51	0.46	3.69
Abn3- While playing I felt frustrated	1.31	0.57	0.54	0.57
Ratings	7.04	2.96	2.04	-0.51

being asked reflects a lower score than the rest of the variables that make up the dimension.

The Activation dimension reflects negative values, consigning all the variables scoring without spheres to the central value of the Likert scale. The results obtained reflect that the use of virtual gamification does not sufficiently enhance nervous, frantic, active or exciting attitudes during the game.

Regarding the Absence of negative effect dimension during virtual gamification, the results are similar to those obtained in face-to-face gamification. This variable reflects equally positive values as the arithmetic mean is very close to the first point of the Likert scale, which reflects the lowest value.

Finally, regarding the ratings obtained during virtual gamification, we observe a positive result in the weighted average out of 10 (M ≈ 6.4/10).

Table 2 Parametric analysis of the results reported by the experimental group

Dimensions and variables	M	ST	As	β^2
Enjoyment	3.08	1.12	1.86	-0.51
Enj1- Playing was fun	3.04	1.13	1.8	-0.71
Enj 2- I liked playing	3.19	1.12	1.96	-0.55
Enj 3- I really enjoyed playing	3.17	1.11	1.95	-0.52
Enj 4- My experience with the game was pleasant	3.21	1.09	2.03	-0.31
Enj 5- I think playing was very entertaining	3.21	1.09	2.03	-0.31
Enj 6- I would play this game by myself even if not asked	2.68	1.19	1.41	-0.69
Absorption	3.24	1.14	1.98	-0.49
Ab1- Playing made me forget where I was	3.09	1.12	1.87	-0.51
Ab2- I forgot my immediate surroundings while playing	3.15	1.16	1.86	-0.65
Ab3- After playing I felt like going back to the real world	3.21	1.16	1.91	-0.63
Ab4- Playing "took me away from everything"	3.19	1.15	1.9	-0.61
Ab5- While playing I was oblivious to my surroundings	3.13	1.15	1.85	-0.61
Ab6- While playing I lost track of time	3.7	1.09	2.47	0.09
Creative thinking and mastery	3.65	1.11	2.39	-0.13
Ctm1- Playing sparked my imagination	3.77	1.14	2.43	-0.06
Ctm2- While playing I felt creative	3.74	1.14	2.41	-0.11
Ctm3- While playing I felt like I could explore things	3.72	1.12	2.42	-0.05
Ctm4- While playing I felt adventurous	3.74	1.14	2.41	-0.11
Ctm5- While playing I felt I was in command	3.57	1.09	2.35	-0.21
Ctm6- While playing I felt influential	3.45	1.06	2.32	-0.2
Ctm7- Playing sparked my imagination	3.58	1.09	2.37	-0.16
Activation	2.14	0.91	1.25	-0.12
Act1- While playing I felt active	1.92	0.8	1.16	-0.13
Act2- While playing I felt nervous	2.21	0.9	1.35	0.5
Act3- While playing I felt frantic	2.02	0.84	1.22	-0.67
Act4- While playing I felt excited	2.4	1.1	1.26	-0.2
Absence of negative affect	1.44	0.7	0.61	0.97
Abn1- While playing I felt annoyed	1.4	0.65	0.61	0.65
Abn2- While playing I felt hostile	1.34	0.61	0.55	1.41
Abn3- While playing I felt frustrated	1.57	0.84	0.68	0.84
Ratings	6.36	2.81	1.91	0.51

Following the comparative analysis, Table 3 shows the results obtained for the independence values between the control group and the experimental group. This analysis was carried out based on students' t-tests and taking a standardized value of $p < 0.05$ as a statistically significant difference. Three levels of correlation strength (d) were established with their respective corrective value (r), from lowest to highest: low ($r < -0.25$), medium ($r = [-0.25, -0.5]$) and high ($r > -0.5$).

In the Enjoyment dimension, a statistically significant difference is observed that reflects superior results in face-to-face gamification compared to virtual gamification,

with a medium correlation strength ($r \approx 0.26$). This result reflects a greater adaptation of face-to-face gamification to the perception of enjoyment and a pleasant experience on the part of the students.

The dimension related to Activation also reflects superior results in face-to-face gamification compared to virtual gamification, with a high correlation ($r \approx 0.59$). This fact reflects difficulties for virtual gamification in enhancing the active participation of the student and in controlling his/her emotions during the game, since this type of activity is generally carried out in closed spaces and without interpersonal contact. Additionally, it reflects a greater degree of adequacy of face-to-face gamification for the promotion of physical activity and for the work of laterality, since it fosters an active environment complemented by excitement about the game.

Regarding the Creative thinking and mastery dimension, a statistically significant difference is observed that reflects superior results in virtual gamification compared to face-to-face gamification, with a medium correlation strength ($r \approx 0.27$). This result reflects a greater adaptation of virtual gamification to the development of imagination, creativity and exploration as well as the ability to develop an attitude of leadership, influence and autonomy.

However, no statistical significance is found in the dimensions related to the sensation of absorption during the game and the absence of negative effect. In both cases, the mean scores are slightly higher in the group that carried out virtual gamification. However, there is not a big enough difference to determine a clear variability between the two types of gamification. Nor is statistical significance found in the ratings obtained by both groups, despite the fact that the control group that carried out face-to-face gamification obtained a slightly higher result.

Table 3 Analysis of the intergroup independence value (control-experimental)

Dimension	Group, M (SD)		M1-M2	Student's t test		d	r
	Control	Experimental		t (df)	p-value		
Enjoyment	3.69 (1.12)	3.08 (1.12)	0.61	3.13 (103)	0.002	0.544	0.263
Absorption	3.17 (1.14)	3.24 (1.14)	-0.07	0.36 (103)	0.721	–	–
Creative	3.01 (1.17)	3.65 (1.11)	-0.64	3.28 (103)	0.001	-0.561	-0.271
Activation	3.68 (1.17)	2.14 (0.91)	1.64	7.89 (103)	0.000*	1.469	0.592
Absence	1.3 (0.56)	1.44 (0.7)	-0.14	0.72 (103)	0.475	–	–
Ratings	7.04 (2.96)	6.36 (2.81)	0.68	1.21 (103)	0.232	–	–

4 DISCUSSION AND CONCLUSIONS

The results obtained in this research on the benefits of using escape rooms in gamified environments are consistent with those obtained from previous research. Initially, the experience developed in the research process favoured the motivation of the students by being in a fun learning environment, which is in line with what has already been stated about gamification in general (Dicheva et al., 2015; Hamari et al., 2014; Majuri et al., 2018) and

escape rooms in particular (Ang et al., 2020; Prieto et al., 2021). The creation of a gamified environment favoured the activation of students, by designing appropriate and stimulating challenges for students to solve individually or collaboratively (Moura & Santos, 2019; Veldkamp et al., 2020).

The gamified experience developed the cognitive, affective and behavioural domains of students, which is in line with the results of other studies (Brady & Andersen, 2021; Chou & Feng, 2019; Parker & Welch, 2021). Throughout the research experience, students experienced a significant development in thinking skills (Anastasiadis et al., 2018; Moura & Santos, 2019) characterized by a high degree of avoidance and absorption in the learning experience, which is consistent with the results presented by Cohen et al. (2020), Lopez-Pernas et al. (2019) and .

The results reveal that the gamified experience also allowed adequate academic performance as well as higher learning outcomes and ratings to be attained. These results are in line with what was reported by Barna and Fodor (2017), Wigfield et al. (2019) and Yildirim (2017) .

The research results shown in this study reflect significant levels of variability in terms of the educational environment of gamification. Gamification applied in a face-to-face environment further enhanced the experience of a pleasant and fun entertainment experience for students in addition to favouring activation in the teaching and learning process. Gamification applied in a virtual environment enhanced students' ability to feel influential, autonomous and to develop a greater sense of creativity and exploration. In both face-to-face and virtual gamification environments, students similarly perceived a high degree of spatial-temporal absorption and an absence of negative effect. Regarding students' ratings, although face-to-face gamification obtained slightly higher results, no statistically significant results were obtained that confirm its effectiveness in improving learning ratings.

Based on all the above-mentioned points, it is concluded that teachers' choice to apply a face-to-face or virtual gamification approach will depend on the specific dimensions that they want to develop in the teaching and learning process in Higher Education. In this way, both gamification environments similarly promote a high degree of spatio-temporal absorption, an absence of negative effect and the acquisition of good ratings. Face-to-face gamification will be more focused on dynamic and entertaining work and student activation, while virtual gamification will be more focused on the development of creative thinking and autonomy. There are differences between the use of face-to-face and virtual escape rooms. However, these differences must be precisely the premises to be taken into account when the teacher opts for a face-to-face or virtual application. Teachers that aim to help students develop their skills using either face-to-face or virtual escape rooms can utilize the results of this study to select the appropriate learning environment and gamification approach when planning their teaching and learning activities, while also taking into consideration students' specific needs and the dimensions that should be cultivated.

Derived from the limitations of the study and the conclusions drawn, several future lines of study can be presented. One of them could focus on the bimodal application of the escape room in various educational stages (primary, secondary and high school education), in

order to make a contrast between them. In addition, within each stage, the escape room could be designed with different missions to find out if the activities influence students' perception and effectiveness.

This study has various theoretical and practical implications. Among the theoretical implications of this study is its contribution to bridging the gap emerging in the literature regarding the comparison of implementing gamification in different learning environments. The results presented assist the educational community by providing insights to facilitate the decision of whether to carry out gamified learning experiences through escape rooms in either face-to-face or virtual environments. It is worth noting that the direction and the goals that the teaching staff pursues with the implementation of this training model are vital in determining the proper environment in which students' specific abilities or skills will be developed as envisioned in this study. This is particularly important since it has been shown that, depending on the environment where the gamified experience takes place, students' viewpoints in the analyzed dimensions vary.

The practical implication of this research focuses on the promotion of active methodologies to carry out a teaching and learning process adapted to the new demands of society and legislative requirements. Additionally, the creation of new training models which teach learning content in an interactive and engaging manner is facilitated. Gamification through escape rooms has been positioned as a model with a great projection in the educational field that can contribute not only to the comprehension of educational content but also to the development of various skills, as shown in this study. Therefore, this research encourages teachers to get to know, trust and carry out new instructional practices of an innovative nature.

REFERENCES

An, T., & Oliver, M. (2021). What in the world is educational technology? Rethinking the field from the perspective of the philosophy of technology. *Learning, Media and Technology*, *46*(1), 6–19. https://doi.org/10.1080/17439884.2020.1810066

Anastasiadis, T., Lampropoulos, G., & Siakas, K. (2018). Digital game-based learning and serious games in education. *International Journal of Advances in Scientific Research and Engineering*, *4*(12), 139–144. https://doi.org/10.31695/ijasre.2018.33016

Ang, J. W. J., Ng, Y. N. A., & Liew, R. S. (2020). Physical and digital educational escape room for teaching chemical bonding. *Journal of Chemical Education*, *97*(9), 2849–2856. https://doi.org/10.1021/acs.jchemed.0c00612

Bai, S., Hew, K. F., & Huang, B. (2020). Does gamification improve student learning outcome? Evidence from a meta-analysis and synthesis of qualitative data in educational contexts. *Educational Research Review*, *30*, 100322. https://doi.org/10.1016/j.edurev.2020.100322

Barna, B., & Fodor, S. (2017). An empirical study on the use of gamification on IT courses at higher education. *Advances in intelligent systems and computing* (pp. 684–692). Springer International Publishing. https://doi.org/10.1007/978-3-319-73210-7_80

Bouchrika, I., Harrati, N., Wanick, V., & Wills, G. (2019). Exploring the impact of gamification on student engagement and involvement with e-learning systems. *Interactive Learning Environments*, *29*(8), 1244–1257. https://doi.org/10.1080/10494820.2019.1623267

Brady, S. C., & Andersen, E. C. (2021). An escape-room inspired game for genetics review. *Journal of Biological Education*, *55*(4), 406–417. https://doi.org/10.1080/00219266.2019.1703784

Cechetti, N. P., Bellei, E. A., Biduski, D., Rodriguez, J. P. M., Roman, M. K., & Marchi, A. C. B. D. (2019). Developing and implementing a gamification method to improve user engagement: A case study with an m-health application for hypertension monitoring. *Telematics and Informatics*, *41*, 126–138. https://doi.org/10.1016/j.tele.2019.04.007

Chou, P. N., Chang, C. C., & Hsieh, S. W. (2020). Connecting digital elements with physical learning contexts: an educational escape-the-room game for supporting learning in young children. *Technology, Pedagogy and Education*, *29*(4), 425–444. https://doi.org/10.1080/1475939X.2020.1775694

Chou, P. N., & Feng, S. T. (2019). Using a. *Tablet Computer Application to Advance High School Students' Laboratory Learning Experiences: A Focus on Electrical Engineering Education. Sustainability*, *11*(2), 1–14. https://doi.org/10.3390/su11020381

Cohen, T. N., Griggs, A. C., Keebler, J. R., Lazzara, E. H., Doherty, S. M., Kanji, F. F., & Gewertz, B. L. (2020). Using escape rooms for conducting team research: understanding development, considerations, and challenges. *Simulation & Gaming*, *51*(4), 443–460. https://doi.org/10.1177/1046878120907943

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness. *Proceedings of the 15th International Academic MindTrek Conference on Envisioning Future Media Environments - MindTrek*, *11*, 9–15. https://doi.org/10.1145/2181037.2181040

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A systematic mapping study. *Journal of Educational Technology & Society*, *18*(3), 75–88.

Galán, J. G., Lázaro-Pérez, C., & Martínez-López, J. (2021). Exploratory Study on Video Game Addiction of College Students in a Pandemic Scenario. *Journal of New Approaches in Educational Research*, *10*(2), 330–346. http://doi.org/10.7821/naer.2021.7.750

García-Peñalvo, F. J., & Corell, A. (2020). La COVID-19: ¿enzima de la transformación digital de la docencia o reflejo de una crisis metodológica y competencial en la educación superior. *Campus Virtuales*, *9*(2), 83–98.

Guckian, J., Eveson, L., & May, H. (2020). The great escape? The rise of the escape room in medical education. *Future Healthcare Journal*, *7*(2), 112–115. https://doi.org/10.7861/fhj.2020-0032

Gudmundsdottir, G. B., Hernández, H., Colomer, J. C., & Hatlevik, O. E. (2020). Student teachers' responsible use of ICT: Examining two samples in Spain and Norway. *Computers & Education*, *152*, 103877. https://doi.org/10.1016/j.compedu.2020.103877

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? - a literature review of empirical studies on gamification. *47th Hawaii International Conference on System Sciences.* https://doi.org/10.1109/hicss.2014.377

Heidari, E., Mehrvarz, M., Marzooghi, R., & Stoyanov, S. (2021). The role of digital informal learning in the relationship between students' digital competence and academic engagement during the COVID-19 pandemic. *Journal of Computer Assisted Learning*, *37*(4), 1154–1166. https://doi.org/10.1111/jcal.12553

Hernández, R., Fernández, C., & Baptista, M. P. (2014). *Metodología de la investigación*. McGraw Hill.

Hung, M., Licari, F. W., Hon, E. S., Lauren, E., Su, S., Birmingham, W. C., & Lipsky, M. S. (2021). In an era of uncertainty: Impact of COVID-19 on dental education. *Journal of dental education*, *85*(2), 148–156. https://doi.org/10.1002/jdd.12404

Iivari, N., Sharma, S., & Ventä-Olkkonen, L. (2020). Digital transformation of everyday life-How COVID-19 pandemic transformed the basic education of the young generation and why information management research should care? *International Journal of Information Management*,

55, 1–6. https://doi.org/10.1016/j.ijinfomgt.2020.102183

Kim, S., Song, K., Lockee, B., & Burton, J. (2017). What is gamification in learning and education? *Gamification in learning and education* (pp. 25–38). Springer International Publishing. https://doi.org/10.1007/978-3-319-47283-6_4

Kolster, R. (2021). Structural ambidexterity in higher education: excellence education as a testing ground for educational innovations. *European Journal of Higher Education*, *11*(1), 64–81. https://doi.org/10.1080/21568235.2020.1850312

Lopez-Pernas, S., Gordillo, A., Barra, E., & Quemada, J. (2019). Examining the use of an educational escape room for teaching programming in a higher education setting. *IEEE Access*, *7*, 31723–31737. https://doi.org/10.1109/access.2019.2902976

Majuri, J., Koivisto, J., & Hamari, J. (2018). Gamification of education and learning: A review of empirical literature. *Proceedings of the 2nd International GamiFIN Conference* (pp. 11–19).

Mengual-Andrés, S., López-Belmonte, J., Fuentes-Cabrera, A., & Pozo-Sánchez, S. (2020). Modelo estructural de factores extrínsecos influyentes en el flipped learning. *Educación XX1*, *23*(1), 75–101. https://doi.org/10.5944/educxx1.23840

Morrell, B. L. M., & Ball, H. M. (2019). Can you escape nursing school? Educational escape room in nursing education. *Nursing Education Perspectives*, *41*(3), 197–198. https://doi.org/10.1097/01.nep.0000000000000441

Moura, A., & Santos, I. L. (2019). Escape room in education: Gamify learning to engage students and learn maths and languages. In B. Duarte et al. (Eds.), *Experiences and perceptions of pedagogical practices with Game-Based Learning & Gamification* (pp. 179–193). University of Minho.

Murillo-Zamorano, L. R., Sánchez, J. A. L., Godoy-Caballero, A. L., & Muñoz, C. B. (2021). Gamification and active learning in higher education: is it possible to match digital society, academia and students' interests? *International Journal of Educational Technology in Higher Education*, *18*(1), 1–27. https://doi.org/10.1186/s41239-021-00249-y

Neumann, K. L., Alvarado-Albertorio, F., & Ramírez-Salgado, A. (2020). Online approaches for implementing a digital escape room with preservice teachers. *Journal of Technology and Teacher Education*, *28*(2), 415–424.

Nicholson, S. (2018). Creating engaging escape rooms for the classroom. *Childhood Education*, *94*(1), 44–49. https://doi.org/10.1080/00094056.2018.1420363

Parker, K. C., & Welch, T. D. (2021). Innovative teaching strategies to escape the anxiety in simulation. *Teaching and Learning in Nursing*, *16*(4), 414–417. https://doi.org/10.1016/j.teln.2021.06.005

Parra, M. E., & Segura, A. (2019). Traducción y validación de la escala de evaluación de experiencias gamificadas (GAMEX). . *Bordón. Revista de pedagogía*, *71*(4), 87–99.

Pitoyo, M. D., Sumardi, S., & Asib, A. (2020). Gamification-Based Assessment: The Washback Effect of Quizizz on Students' Learning in Higher Education. *International Journal of Language Education*, *4*(2), 1–10. https://doi.org/10.26858/ijole.v4i2.8188

Prieto, F. Y., Jeong, J. S., & Gómez, D. (2021). Virtual escape room and STEM content: effects on the affective domain on teacher trainees. *Journal of Technology and Science Education*, *11*(2), 331–342. https://doi.org/10.3926/jotse.1163

Putz, L. M., Hofbauer, F., & Treiblmaier, H. (2020). Can gamification help to improve education? Findings from a longitudinal study. *Computers in Human Behavior*, *110*, 1–12. https://doi.org/10.1016/j.chb.2020.106392

Roig-Vila, R., Padrón, A. L., & Urrea-Solano, M. (2021). Perfil del uso académico del smartphone entre estudiantes noveles universitarios españoles e iberoamericanos. *American Journal of Distance Education*, *35*(1), 66–81. https://doi.org/10.1080/08923647.2021.1880730

Rossi, I. V., De Lima, J. D., Sabatke, B., Nunes, M. A. F., Ramirez, G. E., & Ramirez, M. I. (2021).

Active learning tools improve the learning outcomes, scientific attitude, and critical thinking in higher education: Experiences in an online course during the COVID-19 pandemic. *Biochemistry and Molecular Biology Education*, *49*(6), 888–903. https://doi.org/10.1002/bmb.21574

Roy, R., Van, & Zaman, B. (2018). Need-supporting gamification in education: An assessment of motivational effects over time. *Computers & Education*, *127*, 283–297. https://doi.org/10.1016/j.compedu.2018.08.018

Vanduhe, V. Z., Nat, M., & Hasan, H. F. (2020). Continuance intentions to use gamification for training in higher education: Integrating the technology acceptance model (TAM), Social motivation, and task technology fit (TTF). *IEEE Access*, *8*, 21473–21484. https://doi.org/10.1109/ACCESS.2020.2966179

Veldkamp, A., Grint, L., Van De, Knippels, M.-C. P. J., Joolingen, W. R., & Van. (2020). Escape education: A systematic review on escape rooms in education. *Educational Research Review*, *31*. https://doi.org/10.1016/j.edurev.2020.100364

Vidergor, H. E. (2021). Effects of digital escape room on gameful experience, collaboration, and motivation of elementary school students. *Computers & Education*, *166*. https://doi.org/10.1016/j.compedu.2021.104156

Wang, A. I. (2015). The wear out effect of a game-based student response system. *Computers & Education*, *82*, 217–227. https://doi.org/10.1016/j.compedu.2014.11.004

Wigfield, A., Faust, L. T., Cambria, J., & Eccles, J. S. (2019). Motivation in education. *The oxford handbook of human motivation* (pp. 443–461). Oxford University Press.

Yildirim, I. (2017). The effects of gamification-based teaching practices on student achievement and students attitudes toward lessons. *The Internet and Higher Education*, *33*, 86–92. https://doi.org/10.1016/j.iheduc.2017.02.002

Yılmaz, A., & Soyer, F. (2018). Effect of Physical Education and Play Applications on School Social Behaviors of Mild-Level Intellectually Disabled Children. *Education Sciences*, *8*(2), 1–8. https://doi.org/10.3390/educsci8020089

Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. *Educational Research Review*, *30*, 100326. https://doi.org/10.1016/j.edurev.2020.100326