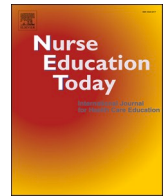




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Research article

An evaluation of undergraduate student nurses' gameful experience whilst playing a digital escape room as part of a FIRST year module: A cross-sectional study

Isabel Antón-Solanas^{a,b}, Beatriz Rodríguez-Roca^a, Fernando Urcola-Pardo^{a,c,*},
Ana Anguas-Gracia^{a,c,d}, Pedro J. Satústegui-Dordá^{a,c}, Emmanuel Echániz-Serrano^a,
Ana B. Subirón-Valera^{a,c}

^a Department of Psychiatry and Nursing, Faculty of Health Sciences, University of Zaragoza, C/Domingo Miral s/n, 50009 Zaragoza, Spain

^b Research group Nursing Research in Primary Care in Aragón (GENIAPA) (GIIS094), Institute of Research of Aragón, Zaragoza, Spain

^c Research group Water and Environmental Health (B43_20R), University Institute of Research in Environmental Science of Aragón, University of Zaragoza, Zaragoza, Spain

^d Research group Safety and Care (GIISA0021), Institute of Research of Aragón, Zaragoza, Spain

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ABSTRACT

Background: The circumstances arising from the COVID-19 pandemic have accelerated the use of digital teaching and learning in health professions education. Digital gamification-based teaching and learning activities are innovative and versatile tools for the acquisition of professional competencies in higher education, which can be used on a range of topics and can be supplemental to other teaching methods.

Objectives: This study aimed to investigate nursing students' gameful experience whilst playing a digital escape room. In addition, we aimed to analyze the students' motivation, learning experience and outcome of the activity, and the students' perception of the degree of achievement of the intended learning outcomes.

Design: Cross-sectional descriptive study.

Participants: A total of 136 undergraduate first year student nurses enrolled in a "Fundamentals of Nursing" course.

Method: The digital escape room game took place online during the academic year 2020–2021. The measures included the GAMEX scale in its Spanish version and a self-reported questionnaire to evaluate the outcome of the escape room game and the degree of achievement of the intended learning outcomes.

Results: More than 80 % of the participants were moderately to very motivated to play the game. Three GAMEX dimensions achieved a mean score of 3 or above 3, namely Enjoyment, Creative Thinking and Absence of Negative effects. The mean score for each of the outcome variables was over 3. However, the degree of achievement of the learning outcomes after exiting the digital escape room was uneven.

Conclusion: Gamification-based teaching and learning activities, such as digital escape rooms, can be effective in fostering specific skills, including teamwork, communication and critical thinking. However, they should be designed carefully, and used as a complement, rather than a substitute, of other educational activities.

1. Introduction

The COVID-19 pandemic has had a profound impact on health professionals education (Seymour-Walsh et al., 2020). As nationwide lockdown restrictions and social distancing measures were implemented, lecturers and students moved away from traditional

educational practices and engaged in innovate and, for the most part, digital teaching and learning (T&L), and assessment activities (Kaup et al., 2020; Sandars and Patel, 2020; Sandhu and de Wolf, 2020). Within days, lectures were quickly transformed into online events and delivered both synchronously and asynchronously (Sandhu and de Wolf, 2020). Accordingly, a range of digital education strategies were

* Corresponding author at: Department of Psychiatry and Nursing, Faculty of Health Sciences, University of Zaragoza, C/Domingo Miral s/n, 50009 Zaragoza, Spain.
E-mail addresses: ianton@unizar.es (I. Antón-Solanas), brodriguez@unizar.es (B. Rodríguez-Roca), furcola@unizar.es (F. Urcola-Pardo), aanguas@unizar.es (A. Anguas-Gracia), pjsd@unizar.es (P.J. Satústegui-Dordá), subiron@unizar.es (A.B. Subirón-Valera).

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integrated in higher education (HE) (Dost et al., 2020; Kaup et al., 2020), such as problem-based learning (Jin and Bridges, 2014), flipped learning (Gopalan et al., 2021) and gamification (Ross et al., 2021).

Although serious gaming had been incorporated into healthcare professions education before COVID-19 (Cole and Ruble, 2021), use of serious educational games became more widespread during the pandemic, as healthcare faculty were challenged to develop a new on-line approach to replace the former face-to-face activities (Suppan et al., 2021). Serious games are defined as games where entertainment is secondary to education (Donovan et al., 2021; Lateef et al., 2021), and where game principles are used for learning, training and skill development (Abensur Guillaume et al., 2021).

An escape game, also known as escape room or breakout, is a game in which a team of players enter a physical or digital space where they are involved and engaged to solve a mystery or problem, usually progressing from one or many rooms looking for clues and solving puzzles (Lateef et al., 2021; Zaug et al., 2022). Escape rooms, as serious games, are innovative and versatile tools for the acquisition of professional competencies in HE, which can be used on a range of topics and can be supplemental to other teaching methods (Anguas-Gracia et al., 2021; Vestal et al., 2021); using active, experimental or problem-based learning (Ghoman et al., 2020).

Digital escape rooms (DER) were designed, developed and delivered during the pandemic with positive effects on learning in nursing education (Vestal et al., 2021). For instance, Rodríguez-Ferrer et al. (2022) used the Mechanics, Dynamics and Aesthetics (MDA) model (Kusuma et al., 2018) to design a DER as part of a massive web-based open course. DER design usually includes two elements, namely game mechanics and game narrative. Game mechanics refers to the challenges and tasks relating to the curricular content (Rodríguez-Ferrer et al., 2022), whilst game narrative defines the “game’s story structure and core emotional elements including theme, plot, characters and dialogue” (Lionbridge Games, 2020).

Some advantages to DER as educational tools have been cited in the literature, including providing conditions for deep learning, promoting collaborative problem-solving skills and active engagement (Cole and Ruble, 2021; Lateef et al., 2021; Rodríguez-Ferrer et al., 2022), allowing students to demonstrate knowledge, apply skills, adopt adequate behaviors (Adams et al., 2018; Donovan et al., 2021; Suppan et al., 2021), inspire critical thinking and guide decision-making (Lateef et al., 2021). However, other authors have argued that they could lead to reduced opportunities to ask questions, hold discussions, and spend time with their peers (Gentry et al., 2019).

As suggested by Sandars and Patel (2020), just as designing effective traditional T&L activities requires careful consideration of some factors, so does effective online T&L activities. These factors include lecturers and students’ previous experience and preferences in using digital resources for T&L, the availability of technology, and the characteristics of the learning content and the curriculum, among others. Thus, academics should systematically evaluate and progressively refine the processes of development, delivery and implementation of online learning in order to achieve effective online T&L (Sandars and Patel, 2020).

Findings from a recent systematic literature review (Makri et al., 2021) of DER as innovative educational tools suggested that there is a relationship between learning and affective skills, such as sense of enjoyment, curiosity, satisfaction, engagement and motivation. Accordingly, they suggested that DER should provide learners with positive experiences in order to increase motivation and engagement, and promote deep, meaningful learning. Whilst many studies have analyzed the impact of gamification on student learning, few have investigated the students’ gameful experience whilst playing a DER. Therefore, we aimed to investigate nursing students’ gameful experience whilst playing a DER using the GAMEX scale, as part of the first-year module Fundamentals of Nursing at the [name of University], in the academic year 20–21. In addition, we analyzed the students’ motivation, learning experience and outcome of the DER, and the students’

perception of the degree of achievement of the intended learning outcomes (ILO).

2. Methodology

2.1. Design

We carried out a cross-sectional study of nursing students’ gameful experience whilst playing a DER in the academic year 20–21. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines in the design and reporting of this study.

2.2. Participants and study location

Our target population were all the undergraduate student nurses enrolled in the first-year course Fundamentals of Nursing at the [name of university] ($N = 165$). We included undergraduate student nurses who were enrolled in the first-year course Fundamentals of Nursing, who attended the synchronous online activity on the set dates and who agreed to complete the post-activity digital survey. We excluded students who did not attend the sessions and therefore did not complete the DER and/or refused to give their informed consent to participate. The final sample comprised a total of $n = 136$ student nurses who met the selection criteria.

This activity was developed as part of a series of online seminars running from September 2020 to May 2021 which, up to the outbreak of COVID-19, had been delivered face-to-face. The DER took place online synchronously. Access to the digital resources necessary to play the game was granted through the [name of University]’s Digital Teaching Ring hosted in Moodle using the institutional ID and password. Due to the large number of students enrolled in the course, the students were divided into two groups, namely group 1 ($n = 82$) and group 2 ($n = 83$), who attended the session on two different days, that is March 23rd and April 13th 2021. All the students were able to solve the puzzles and exit the room in the time allocated to this activity (90 min). The DER was designed by the lecturer responsible for the online seminars running throughout the academic year 20–21 [author’s initials] using the software Genial.ly, a media creation platform that allows its users to design and share media creations and presentations, including DER. We used one of the templates freely available on Genial.ly as the DER background called “mystery breakout”, and customized the characters, missions and scenarios. The DER is freely available and can be access online following this link: <https://view.genial.ly/605882160718030d6b0dce3d/interactive-content-breakout-misterio>.

2.3. Description of the DER

Both the teacher and the students were familiar with synchronous online learning as similar sessions covering different content, and involving a range of digital tools and resources, had already been delivered throughout the course. At the beginning of the session, the students logged into Moodle and joined a plenary meeting room where they were greeted by the facilitator. The facilitator briefly explained the game to the students and divided them into 8 groups of 10–11 students. Each group was given access to a separate meeting room where they interacted during the game. Both the plenary and the meeting rooms were supported by the platform Google Meet.

The aim of the DER was to introduce the topic of pressure ulcers (PU) and allow the students to familiarise themselves with the concept, aetiology, diagnosis, and evidence-based prevention of PU. See Table 1 for a description of the ILO.

In order to exit the room, the students had to solve 6 puzzles or scenarios using the resources and activities available to them through Moodle (specifically designed for this purpose), the DER and/or any other resources at their disposal. We did not add an element of

Table 1
Description of the DER's ILO.

Intended learning outcomes
1. Justify the importance of evaluating the risk for PU and re-evaluating the risk for PU periodically depending on the patient situation.
2. Evaluate the risk for PU using a validated instrument.
3. Describe the main strategies and nursing interventions for preventing PU.
4. Articulate the need to follow clinical practice guidelines for the risk assessment and prevention of PU.
5. Describe the concepts of degree of recommendation and level of scientific evidence, in relation to the risk assessment and prevention of PU.

competition to exit the DER. The only reward system available was the possibility of completing the missions and exiting the game. A description of the different scenarios and screenshots of the DER, design process and game monitoring are available as supplementary material.

2.4. Data collection

The participants individually completed a digital survey immediately after exiting the DER. The survey was programmed so that it could only be completed once, and took the students between 10 and 15 min to fill in.

The digital survey comprised a questionnaire of sociodemographic variables and 2 *ad hoc* questions about student motivation and the learning experience.

In addition, we included six questions based on a questionnaire used in previous studies (Anguas-Gracia et al., 2021; Gómez-Urquiza et al., 2019) to evaluate the outcome of the activity, measured on a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The GAMEX scale in its Spanish version was used to assess the students' gameful experience (Márquez-Hernández et al., 2019). Originally developed by Eppmann et al. (2018) the scale comprises 27 items classified into 6 dimensions: 1) Enjoyment (items 1 to 6), 2) Absorption (items 7 to 12), 3) Creative thinking (items 13 to 16), 4) Activation (items 17 to 20), 5) Absence of negative effects (items 21 to 23), and 6) Dominance (items 24 to 27). Each item is measured on a Likert-type scale ranging from 1 (never) to 5 (always). Cronbach's alpha for the whole scale in its Spanish version is 0.85, ranging from 0.79 to 0.89 for each separate dimension (Márquez-Hernández et al., 2019).

Finally, the students were asked to rate their level of agreement, ranging from strongly disagree to strongly agree, with six statements in relation to their perception of the degree of achievement of the session's ILO.

2.5. Data analysis

A descriptive analysis was conducted, using frequencies and percentages for qualitative variables, and means and standard deviation (SD) for quantitative ones. Internal consistency of the GAMEX scale was calculated using Cronbach's alpha value for each dimension and for the whole instrument. Given the absence of a standardized scoring system for the GAMEX scale, interpretation of the results was purely quantitative. Finally, differences between students who had previous experience of both academic and ludic escape rooms, and those who did not, were analyzed using Mann-Whitney's *U* test. All the analyses were conducted using IBM SPSS-22, applying a level of significance of $p < 0.05$.

3. Results

We analyzed the reliability of the GAMEX scale. Cronbach's alpha for the whole GAMEX scale was 0.93, and ranged from 0.805 (Activation) to 0.944 (Absorption) for each separate dimension.

A total sample of 136 student nurses participated in this study. The sociodemographic characteristics, motivation and learning experience

of the participants are presented in Table 2. The mean age of the participants was 20.05 years (SD 5.19), and most of them were female (80.9 %). Almost half of the student nurses had previous experience of playing escape rooms for either academic (46.3 %) or ludic (47.8 %) purposes, and just over 50 % of the participants never or almost never played games in front of a screen. Whilst less than half (44.8 %) of the student nurses said that they were motivated or very motivated to play the DER, the majority (86 %) thought that playing the DER was positive for learning.

The results from the GAMEX scale, as well as from the evaluation of the DER outcome, are presented in Table 3. Three dimensions achieved a mean score of 3 or above 3, namely Enjoyment, Creative Thinking and Absence of Negative effects. The results from the six questions evaluating the DER outcome suggest that the students generally enjoyed playing the game (mean = 3.41; SD = 1.18); that they believed the game helped them to learn the subject (mean = 3.34; SD = 1.28) and would help them in their final exam (mean = 3.01; SD = 1.20); that playing the DER increased their motivation (mean = 3.08; SD = 1.27) and helped them to activate and apply prior knowledge (mean = 3.25; SD = 1.20); and that they believed that more similar activities should be included in the curriculum (mean = 3.67; SD = 1.17).

Our findings suggest that having a previous experience of academic escape rooms had an impact on the perception of Absence of Negative Effects ($p = 0.002$) (Table 4) experienced during the game.

Significant differences were found between students who had previous experience of playing ludic escape rooms and those who had never played an escape room before (Table 5). Specifically, those who had played an escape room for ludic purposes before scored higher in the

Table 2
Sociodemographic characteristics, motivation and learning experience.

Variable	N (%)
Age	
Mean (SD)	20.05 (5.19)
Sex	
Female	110 (80.9 %)
Male	26 (19.1 %)
Enrolment	
First registration	132 (97.1 %)
Second registration	4 (2.9 %)
Previous experience of academic escape rooms	
No	73 (53.7 %)
Yes	63 (46.3 %)
Previous experience of ludic escape rooms	
No	71 (52.2 %)
Yes	65 (47.8 %)
Number of hours a day paying in front of a screen	
Never or almost never	73 (53.7 %)
<30 min	25 (18.4 %)
30–59 min	18 (13.2 %)
1–3 h	16 (11.8 %)
>3 h	4 (2.9 %)
Level of motivation before the DER	
Very high	15 (11 %)
High	46 (33.8 %)
Moderate	55 (40.4 %)
Low	13 (9.6 %)
Very low	7 (5.1 %)
Playing the DER was positive for learning	
No	19 (14 %)
Yes	117 (86 %)

Table 3

Results from the GAMEX scale and assessment of the DER outcome.

Items	Mean (SD)
GAMEX scale	
GAMEX - enjoyment	3.40 (1.05)
GAMEX - absorption	2.46 (1.11)
GAMEX - creative thinking	3.04 (1.02)
GAMEX - activation	2.76 (0.98)
GAMEX - absence of negative effects	1.78 (1.03)
GAMEX - dominance	2.68 (1.00)
Outcome	
Playing the game helped me learn the subject	3.34 (1.28)
I enjoyed playing the game	3.41 (1.18)
I think the game will help me in the exam	3.01 (1.20)
I remembered and applied knowledge of the subject during the game	3.25 (1.20)
There should be more games of this type in nursing studies	3.67 (1.17)
The game has motivated me to further study, although the exam is still far in time	3.08 (1.27)

dimensions Enjoyment ($p = 0.046$) and Dominance ($p = 0.017$) of the GAMEX scale. In addition, these students reported a higher level of enjoyment ($p = 0.030$), perception of learning ($p = 0.009$) and helpfulness of the DER to pass the exam ($p = 0.027$), and said that they recalled and applied previous knowledge during the game ($p = 0.007$), than the students who had no previous experience of playing ludic escape rooms.

Finally, we evaluated the students' perception of the degree of acquisition of the ILO (Table 6). More than 50 % of the participants agreed or strongly agreed with each one of the statements. Over 80 % and over 90 % of the students, respectively, confirmed that it is important to evaluate the risk for PU and to follow clinical practice guidelines for the risk assessment and prevention of PU.

4. Discussion

The characteristics of our participants were similar to other Spanish undergraduate nursing student populations (Anguas-Gracia et al., 2021; Chover-Sierra and Martínez-Sabater, 2020), with students being young and largely female (80.9 %). We observed that approximately 15 % of the students said that their level of motivation to play the DER was low or very low; interestingly, a similar percentage (14 %) thought that playing the DER was not positive for their learning. Whilst most of the participants were moderately to very motivated to play the DER, some were not keen on this activity. The statistical analyses performed do not allow us to establish a causal relationship between the students' prior level of motivation and their learning experience, but cognitive motivation has been linked to performance whilst playing an escape room before (Gómez-Urquiza et al., 2019; Schei et al., 2020).

It is also important to consider that, whilst some students do well in digital learning environments, others lose motivation and become disengaged (Teodorescu et al., 2021). Whilst many studies (Naciri et al., 2021; Stoeckel et al., 2021) offer a rather positive assessment of the "emergency shift" from on campus to distance learning, others paint a very different picture, with students lacking the knowledge and skills to efficiently use digital technology (Machleid et al., 2020) and developing negative emotions towards online learning (Herbstreit et al., 2021).

Table 4

Impact of previous experience of academic escape rooms.

Items	Experience of academic escape rooms	N	Mean (SD)	Z ^a	p
GAMEX scale					
GAMEX - enjoyment	No	73	3.29 (1.09)	1.285	0.199
	Yes	63	3.53 (0.99)		
GAMEX - absorption	No	73	2.58 (1.07)	1.780	0.075
	Yes	63	2.33 (1.14)		
GAMEX - creative thinking	No	73	3.02 (1.06)	0.013	0.990
	Yes	63	3.07 (0.98)		
GAMEX - activation	No	73	2.89 (0.99)	1.726	0.084
	Yes	63	2.60 (0.96)		
GAMEX - absence of negative effects	No	73	2.02 (1.15)	3.124	0.002
	Yes	63	1.51 (0.78)		
GAMEX - dominance	No	73	2.59 (1.01)	1.107	0.268
	Yes	63	2.79 (0.98)		
Outcome					
Playing the game helped me learn the subject	No	73	3.22 (1.27)	1.170	0.242
	Yes	63	3.48 (1.28)		
I enjoyed playing the game	No	73	3.26 (1.27)	1.455	0.146
	Yes	63	3.59 (1.06)		
I think the game will help me in the exam	No	73	2.96 (1.14)	0.623	0.533
	Yes	63	3.08 (1.29)		
I remembered and applied knowledge of the subject during the game	No	73	3.19 (1.25)	0.500	0.617
	Yes	63	3.32 (1.13)		
There should be more games of this type in nursing studies	No	73	3.53 (1.27)	1.180	0.238
	Yes	63	3.83 (1.02)		
The game has motivated me to further study, although the exam is still far in time	No	73	3.16 (1.28)	0.821	0.412
	Yes	63	2.98 (1.26)		

^a Z = U Mann-Whitney.

According to Chiu et al. (2021), more attention should be paid to promoting and maintaining student (and teacher) motivation, preparing students for technology-assisted learning by fostering digital skills and cultivating self-efficacy during online learning, addressing the psychological needs of students in designing online learning, including relatedness support and emotional development, promoting peer support, and addressing equity and social justice concerns in learning with technology (Chiu and Lim, 2020). Thus, it is possible that some of the participants were not necessarily unmotivated to play the DER, but to do so online. Specifically, concerns have been raised regarding the students' learning habits, insufficient guidance and scarce interaction with the teacher and fellow students (Herbstreit et al., 2021). This has implications on how students should be engaged and supported online, especially when distance learning during the pandemic was neither their preference nor their choice.

Nursing students' gameful experience whilst playing a physical

Table 5
Impact of previous experience of ludic escape rooms.

Items	Experience of ludic escape rooms	N	Mean (SD)	Z ^a	p
GAMEX scale					
GAMEX - enjoyment	No	71	3.23 (1.02)	1.994	0.046
	Yes	65	3.59 (1.05)		
GAMEX - absorption	No	71	2.30 (1.06)	1.574	0.115
	Yes	65	2.64 (1.14)		
GAMEX - creative thinking	No	71	2.91 (1.02)	1.337	0.181
	Yes	65	3.19 (1.00)		
GAMEX - activation	No	71	2.66 (0.89)	0.914	0.361
	Yes	65	2.86 (1.07)		
GAMEX - absence of negative effects	No	71	1.97 (1.13)	1.946	0.052
	Yes	65	1.57 (0.85)		
GAMEX - dominance	No	71	2.46 (0.95)	2.383	0.017
	Yes	65	2.92 (1.00)		
Outcome					
Playing the game helped me learn the subject	No	71	3.11 (1.27)	2.173	0.030
	Yes	65	3.58 (1.25)		
I enjoyed playing the game	No	71	3.17 (1.11)	2.605	0.009
	Yes	65	3.68 (1.21)		
I think the game will help me in the exam	No	71	2.80 (1.17)	2.214	0.027
	Yes	65	3.25 (1.21)		
I remembered and applied knowledge of the subject during the game	No	71	2.99 (1.20)	2.711	0.007
	Yes	65	3.54 (1.13)		
There should be more games of this type in nursing studies	No	71	3.59 (1.15)	0.916	0.360
	Yes	65	3.75 (1.19)		
The game has motivated me to further study, although the exam is still far in time	No	71	2.89 (1.24)	1.788	0.074
	Yes	65	3.29 (1.28)		

^a Z = U Mann-Whitney.

escape room has been evaluated before with excellent results (Anguas-Gracia et al., 2021). The scores from the GAMEX scale suggest that our participants' gameful experience was good, with students reporting a moderately high level of enjoyment and critical thinking, and an absence of negative effects. Similarly, the participants' evaluation of the DER outcome suggested that they moderately enjoyed the learning experience, and that they found it to be moderately helpful for, and contributing to, their learning. Yet, our findings should be interpreted with caution as our scores for each dimension are lower than those reported in two previous studies (Anguas-Gracia et al., 2021; Gómez-Urquiza et al., 2019). There are several possible reasons behind these differences, including the students' characteristics and the characteristics of the T&L activities. In addition, it is worth highlighting that, whilst Gómez-Urquiza et al. (2019) and Anguas-Gracia et al. (2021) delivered their respective escape rooms before the pandemic, ours was implemented in the academic year 2020–2021, when student motivation for

Table 6
Student self-assessment of the degree of acquisition of the session's ILO.

Items	N	%
It is important to evaluate the risk for PU and re-evaluate the risk for PU periodically depending on the patient situation.		
Strongly disagree	6	4.4
Disagree	5	3.7
Neither agree nor disagree	13	9.6
Agree	23	16.9
Strongly agree	89	65.4
I consider myself capable of evaluating the risk for PU using a validated instrument with help and supervision.		
Strongly disagree	11	8.1
Disagree	20	14.7
Neither agree nor disagree	29	21.3
Agree	41	30.1
Strongly agree	35	25.7
I can describe the main strategies and nursing interventions for preventing PU.		
Strongly disagree	7	5.1
Disagree	15	11.0
Neither agree nor disagree	20	14.7
Agree	56	41.2
Strongly agree	38	27.9
I think it is important to follow clinical practice guidelines for the risk assessment and prevention of PU.		
Strongly disagree	6	4.4
Disagree	2	1.5
Neither agree nor disagree	5	3.7
Agree	38	27.9
Strongly agree	85	62.5
I am familiar with the concepts of degree of recommendation and level of scientific evidence in relation to the risk assessment and prevention of PU.		
Strongly disagree	8	5.9
Disagree	23	16.9
Neither agree nor disagree	24	17.6
Agree	49	36.0
Strongly agree	32	23.5

learning may not have been at its highest and the digitalization of content was not necessarily a matter of choice, but of need.

Our findings suggest that students who had previous experience of academic escape rooms scored lower in the GAMEX Absence of negative effects dimension. In turn, students who had prior experience of escape rooms for ludic purposes scored higher in the GAMEX Enjoyment and Dominance dimensions, and all but one of the DER outcome variables. We argue that having prior experience of playing an escape room for academic purposes increased the students' sense of safety in the learning environment and their preparedness to learn whilst playing the DER. Similarly, having prior experience of playing an escape room for ludic purposes, allowed the students to engage and actively participate in the learning experience, minimising their resistance to step out of their learning comfort zone. A similar reflexion was made by McFadyen and Diack (2017), who explored the effectiveness of an innovative practice-based approach to a biomedical science project in a sample of undergraduate pharmacy students, and identified a shift in the students' mindset, from predominantly negative opinions initially to an overwhelming positive viewpoint at the end.

More than half of our participants believed that they had achieved all the ILO. However, the students' self-assessment varied from ILO to ILO. The students rated higher those ILO which measured degree of awareness (ILO 1 and 4), than those that measured newly acquired knowledge (ILO 3 and 5), skill and/or ability (ILO 2). This is not surprising as the characteristics of the session did encourage the participants to become aware of the importance of evaluating the risk of PU and of following evidence-based clinical practice guidelines. However, the degree of

acquisition of new knowledge and skills was probably limited by those same characteristics. Specifically, playing time was limited, although the students were not directly competing against each other, they were aware that their classmates were simultaneously trying to complete the puzzles and exit the DER, and many concepts, content and materials were new to them. This would suggest that, although both the ILO and the questionnaire statements were carefully designed for this session, they were not perfectly aligned to the T&L activities (Biggs and Tang, 2007). In addition, no ILO and questionnaire statements addressing transversal skills, such as teamwork and communication skills, were measured, which is a weakness of this study.

It is likely that our students had benefited from additional scaffolding support to promote effective engagement and active involvement in the DER, and enable them to learn collaboratively in a digital environment (Imperial College London, n.d.). Firstly, more attention should have been paid to the students' access and motivation for participation and engagement in online learning. It is possible that, at the time, some of the students were experiencing negative emotions such as anger, frustration and a sense of loss or missed opportunities for learning. This need for support and reassurance could have been addressed through a higher degree of lecturer digital presence and further opportunities for the students to express their concerns (Crow and Murray, 2020). For example, through individual or group clinics and tutorials with the facilitator, more opportunities for synchronous and asynchronous discussion and frequent email contact. Secondly, more could have been done to help the students feel safe in an online learning environment, develop a sense of belonging and engage equitably and actively in online learning. Negotiating and establishing shared ground rules and expectations at the beginning of the course might have been helpful (Davies et al., 2012). Further, according to our findings, having a previous experience of playing escape rooms improved the students' learning experience. Thus, student learning may have been scaffolded by exposing the students to less complex online activities using similar tools and resources, followed by a debriefing designed to encourage students to share their experience and raise their concerns. Some students may have also benefited from early communication of the sessions' ILOs and T&L activities, as well as early access to some T&L materials and resources. This may have clarified their expectations of the learning experience, and it may have given them a sense of control over their learning. Thirdly, during the academic year 20–21, opportunities for interaction and engagement with teachers and peers were significantly reduced due to social distancing measures. Yet, the students were expected to interact socially and work collaboratively to complete the missions and exit the DER. Creating opportunities for the students to practice online cooperation before playing the DER may have contributed to boosting their confidence in sharing ideas online and increasing mutual trust. Further, group interaction may have been easier had the groups been smaller (4–5 students). Finally, regardless of the degree of successfulness of the activity, an opportunity to reflect not only on the learning experience, but also on the learning journey, may have been beneficial for the students to make sense of their own personal and professional development, and for the teacher to evaluate the T&L activity (Imperial College London, n.d.).

The COVID-19 pandemic has raised interest in online-enabled HE. Recent research has described the role of technologies in nursing education to be positive (Harerimana and Mtshali, 2020). Moreover, other advantages to this type of educational strategy include their relatively low cost (Olszewski and Wolbrink, 2017) and the use of new technologies, which many millennial student nurses may find both attractive and motivating (Jambhekar et al., 2020). However, teachers need to design constructively aligned ILO, T&L activities and assessment tasks that are adapted to the nature and characteristics of a session based on playing a DER (Biggs and Tang, 2007). This includes producing digital, interactive and attractive materials that promote student learning in an engaging and enjoyable environment, and that are suited, and adapted, to the content and wider goals of the course. In addition, it requires teachers to

“rationalise” the use and impact of DER on student learning. Whilst gamification-based T&L activities can be a valuable learning experience, they may not necessarily be effective in increasing student knowledge and skills (Cerenzio and Ocheretyaner, 2021). Yet, they may be effective in helping students learn how to work collaboratively and to communicate as a group (Abensur Vuillaume et al., 2021), how to think critically, apply theory to practice and solve problems (Clauson et al., 2019).

Based on this experience, we recommend that innovative, digital resources such as DER are designed and implemented in nursing courses “with caution”. Whilst, according to recent investigations (Morrell and Ball, 2020; Smith and Paul, 2021; Woodworth, 2021) escape rooms are an innovative and interactive T&L tool that can be applied to nursing education, they should be used as a complement, rather than a substitute, of other T&L strategies in order to create a superior learning style (McDonald et al., 2018). Future studies should analyze the relationship between student motivation before and after playing a DER and the gameful experience, as well as its impact on student learning and degree of acquisition of the learning outcomes.

We wish to highlight some methodological limitations. Although group progress could be monitored through Moodle and the DER as the various groups of students played the game, we were unable to guarantee that all the participants who completed the digital survey had been actively involved in solving the puzzles and completing the missions. Additionally, due to the absence of a standardized scoring system for the GAMEX scale, allowing for the categorization of the results, our findings should be interpreted with caution.

5. Conclusion

The ultimate purpose of education is to provide students with the motivation, skills and tools necessary for lifelong learning. Our findings suggest that the student nurses' gameful online experience was positive, promoting collaborative learning, creative thinking skills and improving their capacity to apply basic nursing knowledge during the game. However, the degree of achievement of the proposed ILO was uneven. This may be due to different factors, including a misestimation of the impact of DER on student learning, factors relating to the characteristics of the teacher, the students, and the session content, and factors relating to the impact on the COVID-19 pandemic on HE during the academic year 2020–2021. Gamification-based T&L activities, such as DER, can be effective in fostering specific skills, including teamwork, communication and critical thinking. However, they should be designed carefully, and used as a complement, rather than a substitute, of other educational activities.

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CRedit authorship contribution statement

Isabel Antón-Solanas: conceptualization, methodology, investigation, writing original draft; **Beatriz Rodríguez-Roca:** investigation, resources, writing review and editing; **Fernando Urcola-Pardo:** methodology, investigation, formal analysis, writing review and editing; **Ana Anguas-Gracia:** investigation, resources, writing review and editing; **Pedro J. Satustegui-Dorda:** formal analysis, writing review and editing; **Emmanuel Echániz-Serrano:** formal analysis, writing review and editing; **Ana B. Subirón-Valera:** conceptualization, methodology, formal analysis, supervision.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.nedt.2022.105527>.

References

- Abensur Guillaume, L., Laudren, G., Bosio, A., Thévenot, P., Pelaccia, T., Chauvin, A., 2021. A didactic escape game for emergency medicine aimed at learning to work as a team and making diagnoses: methodology for game development. *JMIR Serious Games* 9, e27291. <https://doi.org/10.2196/27291>.
- Adams, V., Burger, S., Crawford, K., Setter, R., 2018. Can you escape? Creating an escape room to facilitate active learning. *J. Nurses Prof. Dev.* 34, E1 <https://doi.org/10.1097/NND.0000000000000433>.
- Anguas-Gracia, A., Subirón-Valera, A.B., Antón-Solanas, I., Rodríguez-Roca, B., Satústegui-Dordá, P.J., Urcola-Pardo, F., 2021. An evaluation of undergraduate student nurses' gameful experience while playing an escape room game as part of a community health nursing course. *Nurse Educ. Today* 103, 104948. <https://doi.org/10.1016/j.nedt.2021.104948>.
- Biggs, J., Tang, C., 2007. *Teaching for Quality Learning at University*, 3rd ed. Open University Press, Maidenhead.
- Cerenzio, J., Ocheretyan, E.R., 2021. Impact of an interactive, clinical decision-making workshop on student learning of antimicrobial stewardship principles. *Curr. Pharm. Teach. Learn.* 13, 1492–1497. <https://doi.org/10.1016/j.cptl.2021.09.006>.
- Chiu, T.K.F., Lim, C.P., 2020. Strategic use of technology for inclusive education in Hong Kong: a content-level perspective. *ECNU Rev. Educ.* 3, 715–734. <https://doi.org/10.1177/2096531120930861>.
- Chiu, T.K.F., Lin, T.-J., Lonka, K., 2021. Motivating online learning: the challenges of COVID-19 and beyond. *Asia Pac. Educ. Res.* 1–4 <https://doi.org/10.1007/s40299-021-00566-w>.
- Chover-Sierra, E., Martínez-Sabater, A., 2020. Analysis of spanish nursing students' knowledge in palliative care. An online survey in five colleges. *Nurse Educ. Pract.* 49, 102903 <https://doi.org/10.1016/j.nepr.2020.102903>.
- Clauson, A., Hahn, L., Frame, T., Hagan, A., Bynum, L.A., Thompson, M.E., Kiningham, K., 2019. An innovative escape room activity to assess student readiness for advanced pharmacy practice experiences (APPEs). *Curr. Pharm. Teach. Learn.* 11, 723–728. <https://doi.org/10.1016/j.cptl.2019.03.011>.
- Cole, J.D., Ruble, M.J., 2021. Designing and evaluating game-based learning for continuing pharmacy education using an "escape room" activity. *Curr. Pharm. Teach. Learn.* 13, 1293–1299. <https://doi.org/10.1016/j.cptl.2021.07.007>.
- Crow, J., Murray, J.-A., 2020. Online distance learning in biomedical sciences: community, belonging and presence. *Adv. Exp. Med. Biol.* 1235, 165–178. https://doi.org/10.1007/978-3-030-37639-0_10.
- Davies, R., Yeung, E., Mori, B., Nixon, S.A., 2012. Virtually present: the perceived impact of remote facilitation on small group learning. *Med. Teach.* 34, e676–e683. <https://doi.org/10.3109/0142159X.2012.687490>.
- Donovan, C.M., Cooper, A., Kim, S., 2021. Ready patient one: how to turn an in-person critical care simulation scenario into an online serious game. *Cureus* 13, e17746. <https://doi.org/10.7759/cureus.17746>.
- Dost, S., Hossain, A., Shehab, M., Abdelwahed, A., Al-Nusair, L., 2020. Perceptions of medical students towards online teaching during the COVID-19 pandemic: a national cross-sectional survey of 2721 UK medical students. *BMJ Open* 10, e042378. <https://doi.org/10.1136/bmjopen-2020-042378>.
- Eppmann, R., Bekk, M., Klein, K., 2018. Gameful experience in gamification: construction and validation of a gameful experience scale [GAMEX]. *J. Interact. Mark.* 43, 98–115. <https://doi.org/10.1016/j.intmar.2018.03.002>.
- Gentry, S.V., Gauthier, A., L'Estrade Ehrstrom, B., Wortley, D., Lilienthal, A., Tudor Car, L., Dauwels-Okutsu, S., Nikolaou, C.K., Zary, N., Campbell, J., Car, J., 2019. Serious gaming and gamification education in health professions: systematic review. *J. Med. Internet Res.* 21, e12994 <https://doi.org/10.2196/12994>.
- Ghoman, S.K., Patel, S.D., Cutumisu, M., von Hauff, P., Jeffery, T., Brown, M.R.G., Schmöler, G.M., 2020. Serious games, a game changer in teaching neonatal resuscitation? A review. *Arch. Dis. Child. Fetal Neonatal Ed.* 105, 98–107. <https://doi.org/10.1136/archdischild-2019-317011>.
- Gómez-Urquiza, J.L., Gómez-Salgado, J., Albendín-García, L., Correa-Rodríguez, M., González-Jiménez, E., Cañadas-De la Fuente, G.A., 2019. The impact on nursing students' opinions and motivation of using a "Nursing escape room" as a teaching game: a descriptive study. *Nurse Educ. Today* 72, 73–76. <https://doi.org/10.1016/j.nedt.2018.10.018>.
- Gopalán, C., Butts-Wilmsmeyer, C., Moran, V., 2021. Virtual flipped teaching during the COVID-19 pandemic. *Adv. Physiol. Educ.* <https://doi.org/10.1152/advan.00061.2021>.
- Harerimana, A., Mtshali, N.G., 2020. Using exploratory and confirmatory factor analysis to understand the role of technology in nursing education. *Nurse Educ. Today* 104490. <https://doi.org/10.1016/j.nedt.2020.104490>.
- Herbstreit, S., Gestmann, M., Szalai, C., Diehl, A., 2021. Are medical students equipped for digital studies? Have their hopes and fears been confirmed during Covid-19? What should we consider in the future? *J. Eur. CME* 10, 2014098. <https://doi.org/10.1080/21614083.2021.2014098>.
- Imperial College London. Supporting students with online learning [WWW document]. Imperial College London. URL: <https://www.imperial.ac.uk/staff/educational-development/teaching-toolkit/remote-online-learning/supporting-students-with-online-learning/>. (Accessed 22 April 2022).
- Jambhekar, K., Pahls, R.P., Deloney, L.A., 2020. Benefits of an escape room as a novel educational activity for radiology residents. *Acad. Radiol.* 27, 276–283. <https://doi.org/10.1016/j.acra.2019.04.021>.
- Jin, J., Bridges, S.M., 2014. Educational technologies in problem-based learning in health sciences education: a systematic review. *J. Med. Internet Res.* 16, e251 <https://doi.org/10.2196/jmir.3240>.
- Kaup, Soujanya, Jain, R., Shivalli, S., Pandey, S., Kaup, Soumya, 2020. Sustaining academics during COVID-19 pandemic: the role of online teaching-learning. *Indian J. Ophthalmol.* 68, 1220–1221. https://doi.org/10.4103/ijo.IJO_1241_20.
- Kusuma, G.P., Wigati, E.K., Utomo, Y., Putera Suryapranata, L.K., 2018. In: Analysis of Gamification Models in Education Using MDA Framework. *Procedia Computer Science, The 3rd International Conference on Computer Science and Computational Intelligence (ICCCSCI 2018) : Empowering Smart Technology in Digital Era for a Better Life*, 135, pp. 385–392. <https://doi.org/10.1016/j.procs.2018.08.187>.
- Lateef, F., Lim, R.E., Loh, M.W.Y., Pang, K.Y.C., Wong, M., Lew, K.X., Madhavi, S., 2021. Taking serious games forward in curriculum and assessment: starting infusions right every time. *J. Emerg. Trauma Shock* 14, 232–239. https://doi.org/10.4103/jets.jets_82_21.
- Lionbridge Games, 2020. Narrative game design for every audience [WWW document]. Game localization, translation and testing from lionbridge. URL: <https://games.lionbridge.com/blog/designing-winning-game-narrative-every-audience/>. (Accessed 13 May 2022).
- Machleid, F., Kaczmarczyk, R., Johann, D., Balciunas, J., Atienza-Carbonell, B., von Maltzahn, F., Mosch, L., 2020. Perceptions of digital health education among european medical students: mixed methods survey. *J. Med. Internet Res.* 22, e19827 <https://doi.org/10.2196/19827>.
- Makri, A., Vlachopoulos, D., Martina, R.A., 2021. Digital escape rooms as innovative pedagogical tools in education: a systematic literature review. *Sustainability* 13, 4587. <https://doi.org/10.3390/su13084587>.
- Márquez-Hernández, V.V., Garrido-Molina, J.M., Gutiérrez-Puertas, L., García-Viola, A., Aguilera-Manrique, G., Granados-Gómez, G., 2019. How to measure gamification experiences in nursing? Adaptation and validation of the gameful experience scale [GAMEX]. *Nurse Educ. Today* 81, 34–38. <https://doi.org/10.1016/j.nedt.2019.07.005>.
- McDonald, E.W., Boulton, J.L., Davis, J.L., 2018. E-learning and nursing assessment skills and knowledge – an integrative review. *Nurse Educ. Today* 66, 166–174. <https://doi.org/10.1016/j.nedt.2018.03.011>.
- McFadyen, M.C.E., Diack, L., 2017. I can step outside my comfort zone. *Pharmacy (Basel)* 5, 59. <https://doi.org/10.3390/pharmacy5040059>.
- Morrell, B.L.M., Ball, H.M., 2020. Can you escape nursing School? Educational escape room in nursing education. *Nurs. Educ. Perspect.* 41, 197–198. <https://doi.org/10.1097/01.NEP.0000000000000441>.
- Naciri, A., Radid, M., Kharbach, A., Chems, G., 2021. E-learning in health professions education during the COVID-19 pandemic: a systematic review. *J. Educ. Eval. Health Prof.* 18, 27. <https://doi.org/10.3352/jeehp.2021.18.27>.
- Olsewski, A.E., Wolbrink, T.A., 2017. Serious gaming in medical education: a proposed structured framework for game development. *Simul. Healthc.* 12, 240–253. <https://doi.org/10.1097/01.SIH.0000000000000212>.
- Rodríguez-Ferrer, J.M., Manzano-León, A., Cangas, A.J., Aguilar-Parra, J.M., 2022. A web-based escape room to raise awareness about severe mental illness among university students: randomized controlled trial. *JMIR Serious Games* 10, e34222. <https://doi.org/10.2196/34222>.
- Rodríguez-Ferrer, J.M., Manzano-León, A., Cangas, A.J., Aguilar-Parra, J.M., Fernández-Jiménez, C., Fernández-Campoy, J.M., Luque de la Rosa, A., Martínez-Martínez, A.M., 2022. Acquisition of learning and empathy towards patients in nursing students through online escape room: an exploratory qualitative study. *Psychol. Res. Behav. Manag.* 15, 103–110. <https://doi.org/10.2147/PRBM.S344815>.
- Ross, J.M., Wright, L., Arikawa, A.Y., 2021. *Adapting a Classroom Simulation Experience to an Online Escape Room in Nutrition Education*. Nutrition and Dietetics Faculty Publications.
- Sanders, J., Patel, R., 2020. The challenge of online learning for medical education during the COVID-19 pandemic. *Int. J. Med. Educ.* 11, 169–170. <https://doi.org/10.5116/ijme.5f20.55f2>.
- Sandhu, P., de Wolf, M., 2020. The impact of COVID-19 on the undergraduate medical curriculum. *Med. Educ. Online* 25, 1764740. <https://doi.org/10.1080/10872981.2020.1764740>.
- Schei, V., Sverdrup, T.E., Andvik, E., 2020. "Let's get out of Here!": cognitive motivation and maximizing help teams solving an escape room. *Front. Psychol.* 11, 2196. <https://doi.org/10.3389/fpsyg.2020.02196>.
- Seymour-Walsh, A.E., Bell, A., Weber, A., Smith, T., 2020. Adapting to a New Reality: COVID-19 Coronavirus and Online Education in the Health Professions [WWW Document]. <https://doi.org/10.22605/RRH6000>.
- Smith, V.R., Paul, P.A., 2021. Escape room: innovative teaching strategy to stimulate critical thinking/judgment in nursing students. *Nurs. Educ. Perspect.* 42, E154–E155. <https://doi.org/10.1097/01.NEP.0000000000000700>.
- Stoehr, F., Müller, L., Brady, A., Trilla, A., Mähringer-Kunz, A., Hahn, F., Düber, C., Becker, N., Wörns, M.-A., Chapiro, J., Hinrichs, J.B., Akata, D., Ellmann, S., Huisman, M., Koff, D., Brinkmann, S., Bamberg, F., Zimmermann, O., Traikova, N.I., Marquardt, J.U., Chang, D.-H., Rengier, F., Auer, T.A., Emrich, T., Muehler, F., Schmidberger, H., Baeßler, B., dos Santos, D.P., Kloeckner, R., 2021. How COVID-19 kick-started online learning in medical education—the DigiMed study. *PLOS ONE* 16, e0257394. <https://doi.org/10.1371/journal.pone.0257394>.
- Suppan, M., Stuby, L., Harbarth, S., Fehlmann, C.A., Achab, S., Abbas, M., Suppan, L., 2021. Nationwide deployment of a serious game designed to improve COVID-19 infection prevention practices in Switzerland: prospective web-based study. *JMIR Serious Games* 9, e33003. <https://doi.org/10.2196/33003>.

- Teodorescu, D., Aivaz, K.A., Amalfi, A., 2021. Factors affecting motivation in online courses during the COVID-19 pandemic: the experiences of students at a Romanian public university. *Eur. J. High. Educ.* 1–18. <https://doi.org/10.1080/21568235.2021.1972024>.
- Vestal, M.E., Matthias, A.D., Thompson, C.E., 2021. Engaging students with patient safety in an online escape room. *J. Nurs. Educ.* 60, 466–469. <https://doi.org/10.3928/01484834-20210722-10>.
- Woodworth, J.A., 2021. Escape room teaching pedagogy in the didactic learning environment for nursing. *Nurse Educ.* 46, 39–42. <https://doi.org/10.1097/NNE.0000000000000847>.
- Zaug, P., Gros, C.-I., Wagner, D., Pilavyan, E., Meyer, F., Offner, D., Strub, M., 2022. Development of an innovative educational escape game to promote teamwork in dentistry. *Eur. J. Dent. Educ.* 26, 116–122. <https://doi.org/10.1111/eje.12678>.