

Learning to Escape or Escaping to Have Fun: Do Educational Escape Rooms Positively Impact Students' Performance in Business Higher Education?

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Abstract: Interest in and the use of escape rooms (ERs) for educational purposes have increased recently (Taraldsen et al, 2020; Veldkamp et al, 2020). There are many benefits to using ERs in education, including improved engagement and motivation (Buchner et al, 2022; Taraldsen et al, 2020; Veldkamp et al, 2020). However, findings concerning the impact of the use of ERs on students' actual learning are mixed (Veldkamp et al, 2020). This study aims to investigate this impact by exploring a case in which a digital ER was implemented in a blended online course. This ER was designed to be used in a business course including more than 150 business undergraduate students distributed across 15 campuses. The specific learning objective of the escape room was to enhance students' understanding of the most important concepts of the course in preparation for the midterm examination. The authors compare students' performance across two different sections of the same course, i.e., a control section and another section in which the ER was implemented. In addition, the authors administered a survey to comprehend students' ER perception. Results show that while students had a positive perception of the use of the digital educational ER, its usage did not affect their performance on the midterm examination.

Keywords: active learning, escape room, higher education, business

1. Introduction

Since their introduction in 2007, the use of escape rooms (ERs) has increased exponentially, beginning in Asia and later expanding to Europe, Australia and North America (Nicholson, 2015). ERs have also been used in a widespread manner for more purposes than entertainment, gaining a foothold in the field of education (Taraldsen et al, 2020; Veldkamp et al, 2020). A vast number of educational escape rooms (EERs) have been documented in fields such as medicine and computer science (Veldkamp et al, 2020). However, evidence concerning the use of ERs in business education remains scarce. Furthermore, evidence concerning the use of digital educational escape rooms (DEERs'), i.e., EERs that are conducted remotely using digital tools (Gordillo et al, 2020; Huang, Kuo, and Chen, 2020; Makri, Vlachoupoulos, and Martina, 2021), is also limited. This article aims to illuminate these topics in further detail. Two research questions guided this study: Does the use of a DEER positively impact students' course performance? What are management students' perceptions of the use of a DEER?

We developed a DEER for a blended undergraduate course offered every semester with an average enrollment of more than 150 students distributed across 15 campuses that are in different cities. The design of the DEER was intended to enhance students' knowledge of the key concepts of the course and support their preparation for a midterm examination. The DEER was divided into three different phases or levels in which students were asked to solve a puzzle related to the topics of the course. At the end of the DEER, students discovered a room where they could participate in additional review of the contents discussed in the course. The midterm exam was administered two weeks after students completed the DEER. Following completion of the DEER, students answered a survey regarding their experience. In addition, the performance of these students on the midterm exam was compared to the performance of students in another section of the class of a previous semester. Data showed that while students' perceptions of the impact of the use of the DEER as preparation for their exam were positive, their grades were not significantly different from those of students in the section that did not use the DEER.

This work consists of five sections. The first section explores the theoretical background. The second section explores the methodology of this research and describes its different stages and overall process starting with the academic design of the DEER. The third section presents the findings of the study. The fourth section discusses the limitations of the study. Finally, the fifth section presents the conclusions of the study.

2. Theoretical background

The use of ERs in education is related to two other trends: gaming and experiential learning. Gaming has been established as a common strategy to facilitate learning at all academic levels and can be defined as “the use of game design elements in non-game contexts” (Deterding et al, 2011; pp. 9). This technique consists of transferring the concepts and mechanics used in games to an educational context. In recent years, the gaming strategy has evolved into a variety of more realistic activities. In turn, experiential learning or active learning is a new approach to the learning process. It engages students with specific learning content to enable them to acquire and secure new knowledge and increase their ability to retain information (Strickland & Kaylor, 2016).

Originally intended for recreational purposes, ERs can be defined as “live-action team-based games where players discover clues, solve puzzles, and accomplish tasks in one or more rooms in order to accomplish a specific goal (usually escaping from the room) in a limited time” (Nicholson, 2005; p .1). ERs were also developed to use physical space in designing players’ experiences. The first documented escape room was created by a company called SCRAP and was known as the “Real Escape Game” (Nicholson, 2015). This ER was conducted in Kyoto, Japan, in mid-2007 and consisted of a game featuring one room in which teams including 5 or 6 people participated. Since that time, recreational ERs have expanded at a rapid rate from Asia to Europe and later to Australia and North America (Nicholson, 2015).

When educators became aware of the possible benefits of using ERs to challenge and test students’ knowledge of specific topics or concepts, a natural evolution of their application to educational environments took place. When ERs are used in education, students are involved in the learning process in a fun format that can be beneficial with respect to their achievement of learning goals. In this case, the escape room is part of the objective of gamification. Educational games are explorative, problem-based learning scenarios that may be fun but do not truly contribute to learning without the inclusion of additional instructional elements (Buchner et al, 2022; Taraldsen et al, 2020; Veldkamp et al, 2020).

Interest in and the use of escape rooms (ERs) for educational purposes have increased recently (Taraldsen et al, 2020; Veldkamp et al, 2020). EERs are widely used for developing skills in a variety of fields, such as medicine, social sciences, and computer science; however, their use in the field of business education appears to be lacking. EERs are designed to take into account the preferences and characteristics of a concrete group and the desired educational outcomes (Veldkamp et al, 2020). This type of resource is immersive, which entails that they are focused on “providing information or stimulation for a number of senses, not only sight and sound” (“Immersive”, 2022). The intention of EER designers is to facilitate higher levels of success because EERs represent a positive experience for students while simultaneously allowing them to attain the expected learning goals (Veldkamp et al, 2020).

Some of the benefits of using escape rooms in the context of education are the active participation of students, stimulation of their learning through play and the incorporation of puzzle solving as an educational challenge. Both students and teachers perceive that while participating in escape rooms, students are more engaged and active than in the case of regular classes (Cain, 2019). In addition, escape rooms encourage collaboration and teamwork, since team members must make decisions jointly to obtain answers. Students also learn to work under pressure since they have limited time to complete the exercise.

Learning via EERs is associated with increased learner engagement and motivation, which can in turn positively affect learning achievement (Buchner et al, 2022; Taraldsen et al, 2020; Veldkamp et al, 2020). In an escape room, students make the decisions, and the professor plays the role of a guide, occasionally even allowing students who make mistakes to learn from them and move forward. This situation allows students to become involved in the learning process, motivates them and is simultaneously fun for them.

Both professors and students have expressed a positive perception of the implementation of an EER; it is considered to serve as a good resource for developing a better understanding of the information and applying or practicing knowledge, and it also functions as an instrument for evaluating the concepts and skills that students develop (Veldkamp et al, 2021). In summary, using different tools to encourage and evaluate students provides a more extensive means of assessing their learning outcomes and changes the ways in which feedback is provided as well as the way in which relationships with students are developed.

A great deal of literature has investigated the successful implementation of EERs. Several recommendations have been made based on empirical knowledge, particularly by the authors Veldkamp et al (2020). Some of these recommendations include the following: every effort must be focused on achieving the desired learning outcomes by considering the most suitable pedagogical techniques and designs for the game; the role of the professors is challenging because they are required both to monitor and to guide the experience, but simultaneously, students must encounter a certain level of autonomy and immersion while performing the activity. Finalizing the game with a debriefing after is highly recommended. The duration of such a debriefing can vary depending on the ER and professors' choices, with some lasting for 5 minutes and others taking up to 2 hours. In such a debriefing, the professor encourages students to share their experiences, comments, or questions regarding the EERs and offers feedback concerning their results. In addition, professors using EERs must define the assessment carefully in accordance with the learning outcomes.

While the majority of EERs appear to be conducted in physical spaces, they can also take place remotely in virtual environments (Gordillo et al, 2020). In this case, the EER is designed by using digital tools (Gordillo et al, 2020; Huang, Kuo, and Chen, 2020; Makri, Vlachoupoulos, and Martina, 2021) that "can supplement the physical components in an EER" (Makri, Vlachoupoulos, and Martina, 2021, pp. 4). Digital educational escape rooms (DEERs) offer advantages such as reduced costs or increased convenience and adaptability (Makri, Vlachoupoulos, and Martina, 2021). In the following, we explain in detail how we designed and conducted this study.

3. Methodology

Two research questions guided this study: Does the use of a DEER positively impact students' course performance? What are management students' perceptions of the use of a DEER? This study employed an experimental approach to understand the effects of the use of a DEER on students' performance on a midterm examination. The study considered a control group that corresponded to a section of the course delivered in the fall semester of 2021. The treatment consisted of the implementation of a DEER in another section of the same course that was delivered in the spring semester of 2022. To comprehend students' perceptions of the use of a DEER we administered a survey. Data collected from both the experiment and the survey was analyzed. Next, we describe the design of the DEER and the process we followed to conduct this research.

The DEER had the specific learning objective of allowing students to review the most important concepts of the course and preparing students for the midterm exam. The DEER was implemented in the context of a business course including 160 business undergraduate students distributed across 15 campuses that were located in different cities. This course was a blended online course taught via team teaching. Accordingly, two professors were responsible for the live session and the general content of the course. Additionally, each student had a tutor professor who oversaw their assignments, shared important announcements, and provided personal follow-up to develop closer relationships with the students. This course featured one real-time session of one hour and a half conducted via Zoom once per week with the lead professors. Apart from the live session, students were required to work on their assignments for the week at their own pace and submit their deliverables to the Canvas Learning Management Platform (LMS) according to schedule. The course was 16 weeks long.

This study was developed via a five-stage process: academic design of the DEER, technical design, implementation, data collection and analysis (Figure 1).

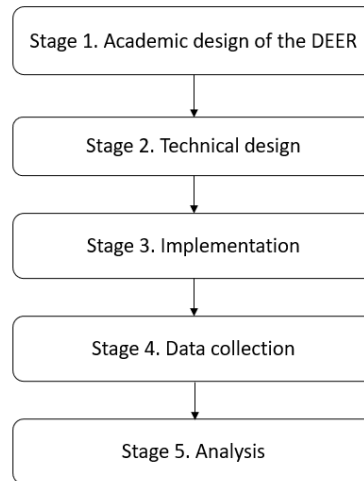


Figure 1: Stages of the development of the DEER.

3.1 Stage 1. Academic design of the DEER

During the first stage, the professors of the course determined the date on which the DEER was to be implemented. Bearing this date in mind, the content of the DEER was defined, that is, the topics to be covered were identified. After defining the topics of study, we identified the main concepts they included. Two main topics were selected, and for each topic, the authors planned the design of the DEER. The design focused on the development of puzzles related to the main concepts. The first puzzle consisted of a crossword featuring an acronym for the main concept. For the second puzzle three questions were included alongside appropriate clues, which consisted of a video, or an article intended to help students find the right answer. The initial academic design of the DEER took place over a period of two weeks, although the design was also refined during subsequent phases.

3.2 Stage 2. Technical design

The second stage was carried out in collaboration with the developers of the DEER. First, the developers required the authors to develop the storytelling associated with the DEER to ensure that the puzzles were aligned and introduced in a logical way. The second activity was the task of refining puzzles and how they were to be presented. A key consideration was and what the best choice would be to ensure that the students could have fun while solving the puzzle. The design choices lead to a sequential structure (Veldkamp et al, 2020) of the DEER. The developers prepared a templated featuring the rooms' sequence and the information required for each aspect of the room to guide the whole process, which was created using the application Figma (Figure 2).

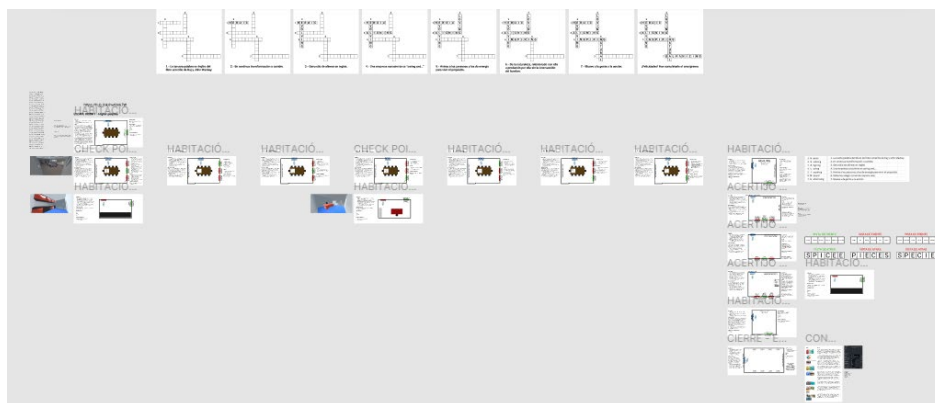


Figure 2: Figma of Digital Escape Room

The developers proposed the use of the Mozilla Hubs digital application based on the technical requirements of the DEER's design. Follow-up meetings were conducted every two to three weeks, and during these meetings, adjustments were made to the design of the DEER. The final design comprised 14 rooms around 2 main puzzle types. Among these rooms there were rooms that served as transitions and the final one which was dedicated to the review of topics of the course.

Once the final version of the DEER was complete, the authors tested it. Once the DEER was approved, the developers generated one link for each of the teams from the section of the course. The technical design step had a duration of approximately two months. Next, we describe the DEER in more detail.

The storytelling of the DEER focuses on the succession of a company and a main character named David, who is the new leader of the organization and wants to align the organization with the characteristics of a conscious company. This character invites the students to help in this process by completing the puzzles in the rooms to advance. David and the company are introduced in a room that does not include a puzzle (Figure 3). After completing this introductory room, students advance to Room 1 (Figure 4), in which they are required to solve the first puzzle (Figure 5).

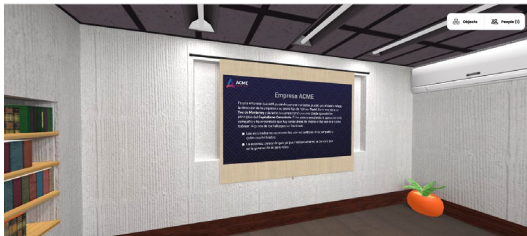


Figure 3: Introductory Room.



Figure 4: Room 1.

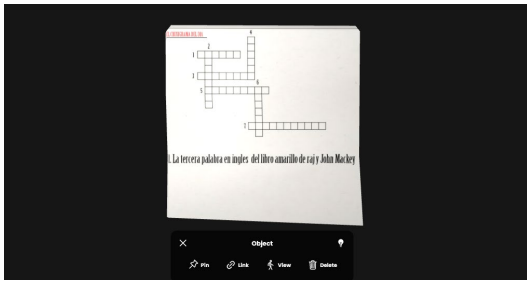


Figure 5: Riddle of Room 1.



Figure 6: Escape Room Doors.



Figure 7: Sample of a Clue.

The first puzzle consists of a crossword. To advance to the next room students need to choose the door that corresponds to the first letter of the word that meets the criteria of the crossword (see Figure 6). In case they do not know which door to choose, clues (see Figure 7) are available in all rooms. If students choose the wrong door, they enter a kitchen or an office, while if they choose the correct door, they continue to the next element of the crossword (Figure 6). By finding the right answer and choosing the correct door students continue advancing through the rest of the crossword. In each new room students see the progress made with the crossword. They advance until the crossword is completed and reach a transition door that congratulates them and leads them into a room with the second puzzle which consists of a set of questions. Students must solve 3 questions that correspond to 3 different rooms to access the final room where the main character of the story awaits to congratulate and thank them for their help. In this final room there is review of concepts related to the topics included in the DEER (Figure 9). By approaching the screen elements of the room, students see and hear a video that explains the main topics of the course.



Figure 8: Second Puzzle.



Figure 9: Final Room of Digital EER.

3.3 Stage 3. Implementation

To enable the students to familiarize themselves with the digital application used to complete the DEER, the authors assigned a practice activity one week before administering the DEERs. This activity was a non-formative practice activity featuring a single room using the same digital application that was used for the DEER. Students were required to submit evidence of completion merely to collect evidence concerning who completed the assignment. The DEERs were conducted one week prior to the scheduled time for the midterm examination. All instructions for the activity were available in an activity on Canvas LMS.

On the day when the DEER was conducted, the Zoom session started with general comments regarding the previous week, and then the authors provided the general instructions for the DEERs. The students were divided into 33 breakout rooms for the course, and each team used a specific link to access the DEER. The DEER was scheduled to last 50 minutes, and teams could ask for help if needed. In the main session, the faculty and a technical support team were available in case any technical issue arose. Once students had completed or the allotted time had passed, all teams returned to the main session. The session concluded with general announcements related to the course; following the session, students completed the feedback survey regarding their experience using the DEER.

3.4 Stage 4. Data collection

During the fourth stage, i.e., data collection, a survey was administered to students following their completion of the midterm examination. These questions were drawn from a prior work by Lopez-Pernas, which was published in December 2019. We discarded 4 questions that were specific to the context of the author (Lopez-Pernas, 2019). In addition, we adapted 2 questions, one that referred to the number of members of the team, and another that referred to the duration of the ER. The results of the survey are shown in the findings section.

In addition to the survey, Data concerning the midterm exam grades of students in two different sections across different terms were collected. The terms selected were August to December 2021 and February to June 2022. We eliminated grades of zero for students who had dropped the course. For both terms, the number of grades was 160. For the term lasting from February to June 2022, we introduced open ended questions to the midterm exam; thus, to facilitate comparison to the term from 2021, we deducted the total of these questions (24 points) from individuals' grades and subsequently recalculated the grade based on the total number of points possible (76 points).

3.5 Stage 5. Analysis

The two research questions that guided the study demanded a different analytical approach. To understand the impact of the DEER on students' performance in the midterm examination, grades from both samples had to be compared using the statistical technique most appropriate to the data. To evaluate students' perceptions of the use of the DEER, simple descriptive statistics were calculated. Findings for both research questions are presented next.

4. Findings

The findings of this study can be divided into two sections. First, we present the results obtained after comparing students' performance on the midterm examination. Second, we discuss the findings related to the survey of students' perceptions of using the DEER.

To analyze the data from the Midterm grades, we began by evaluating the distribution of the data. First, we generated density plots for the two samples, Fall 21 and Spring 22 (see Figures 10 and 11). The plots evidenced that both datasets were not normally distributed.

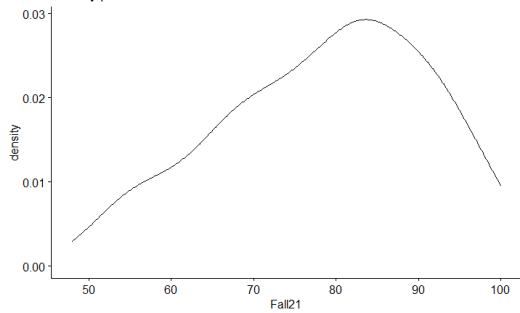


Figure 10: Density Plot Fall 21.

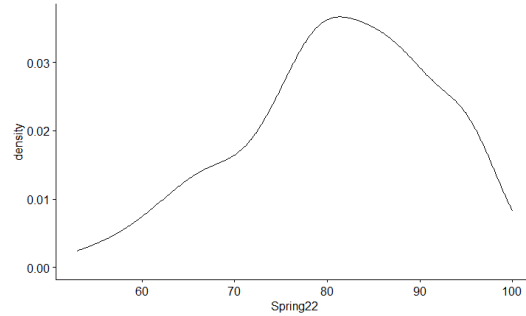


Figure 11: Density Plot Spring 22.

In addition, we tested both samples using the Shapiro–Wilk test, and the results (Table 1) confirmed that the data were not normally distributed.

Table 1: Results on the midterm examinations.

Shapiro-Wilk Test normality test	
W = 0.95311	p-value = 3.363e-05

The following hypotheses guided the rest of the analysis to evaluate the effect of the DEER use in student’s performance.

H0: $\mu_1 = \mu_2$ The use of escape rooms improves students’ performance on midterm examinations.

H1: $\mu_1 \neq \mu_2$ The use of escape rooms does not improve students’ performance on midterm examinations.

Because the data did not fit a normal distribution, these hypotheses were tested using the Wilcoxon formula in RStudio. Wilcoxon test results are shown in Table 2.

Table 2: Results on the midterm examinations.

Period	Number of students	Mean	Std Deviation	Variance	Wilcoxon	alfa $\alpha = 0.05$
Fall 2021	160	79	12.62	159.28	W = 11680 p value = 0.1748	
Spring 22	160	81	10.33	106.81		

After conducting the Wilcoxon test, H0 could not be rejected. Thus, the results show that students’ performance does not differ significantly when a DEER is implemented. In the following section, we discuss the limitations of this study.

Concerning the survey administered to students following the completion of their midterm examination, most respondents noted that their experience with the DEER was positive, with almost half of respondents declaring that it was very good (Table 3). The trend was the same regarding students’ perceptions of the impact of the DEER on their mastery of knowledge pertaining to the course. Their perceptions of fun were even more positive, with almost 56 percent of students rating their degree of fun as 5. Moreover, students agree that the experience was immersive. This finding is interesting, as the DEER was designed to use a virtual platform instead of a physical space. In contrast, students’ responses regarding the levels of stress provoked by the DEER exhibited more variation. Students mostly felt stressed while participating in the DEER.

In terms of the difficulty of the DEER, according to the survey results, more than 80 percent of students perceived that while completing the activity was relatively easy, the difficulty of such completion was related to the student’s mastery of the course contents. Students’ responses showed that overall, they felt prepared to succeed in the DEER.

Table 3: General results of the survey.

Question	Average	Std Dev
1. What is your general opinion on the escape room? (1 poor - 5 very good)	4.13	1.04
2. The escape room allowed me to improve my knowledge of the course materials (1 strongly disagree - 5 strongly agree)	4.13	1.03
3. The escape room was fun for me (1 strongly disagree - 5 strongly agree)	4.16	1.14
4. The escape room was an immersive experience (1 strongly disagree - 5 strongly agree)	4.13	1.14
5. The escape room was a stressful experience (1 strongly disagree - 5 strongly agree)	2.93	1.47
6. The escape room was too difficult (1 strongly disagree - 5 strongly agree)	2.66	1.45
7. The difficulty of the escape room lies in the mastering the course materials (1 strongly disagree - 5 strongly agree)	3.64	1.22
8. I think I was sufficiently prepared to succeed in the escape room (1 strongly disagree - 5 strongly agree)	4.18	0.86
9. The escape room was well-organized (1 strongly disagree - 5 strongly agree)	4.12	1.10
10. The duration of the escape room (50 minutes) was adequate (1 strongly disagree - 5 strongly agree)	4.02	1.06
11. I wish I had received more help during the escape room (1 strongly disagree - 5 strongly agree)	3.13	1.40
12. The initial guidance provided was enough (1 strongly disagree - 5 strongly agree)	3.88	1.09
13. The supervision of the activity was adequate (1 strongly disagree - 5 strongly agree)	4.13	1.05
14. I liked participating in the escape room with a team (1 strongly disagree - 5 strongly agree)	4.25	1.15
15. I would rather have participated in the escape room on my own (1 strongly disagree - 5 strongly agree)	2.67	1.55
16. All members of the team were equally involved in solving the different puzzles (1 strongly disagree - 5 strongly agree)	4.04	1.21
17. Would you like other courses to include activities like this (even if it was not for a grade)?	Yes 83%	No 17%
18. Would you recommend other students to participate in the escape room (even if it was not for a grade)?	Yes 83%	No 17%

Overall, students' answers to questions regarding the design of the DEER were positive. Most students noted that they thought the DEER was well organized and that its duration was appropriate. Opinions pertaining to the assistance that students received during the experience exhibited more variation. More than 80 percent of students reported that the guidance and supervision associated with the DEER was adequate. Students were positive regarding the notion of solving the DEER as part of teams rather than participating by themselves. The engagement of team members appeared high with more than 70 percent of students felt all team members were involved in solving the puzzles.

The results of the survey showed that most students want more courses to include DEERs, and they recommended that other students participate in DEERs even if the activity is not graded.

5. Limitations of the study

This study faces certain limitations. First, the format of the midterm examination was changed between one term and the other. Specifically, open-ended questions were included. While we omitted the scores pertaining to questions that were different from those used during the August 2021 term, it is possible that this adjustment could have had an impact on the scores used for the February term. Second, the DEER was designed and executed in the form of a team activity; thus, students' performance on the midterm examination was not necessarily influenced by students' completion of the DEER equally across all students. A third limitation is related to the technological requirements of the DEER. Some students experienced technological difficulties and participated by following their peers' navigation screens via Zoom. In addition, because not all operating systems supported the application, some students could not have the same experiences as others. Moreover, students did not receive the same levels of support during their DEER experiences. Some teams received more attention and guidance during the activity than others. A fifth limitation is associated with students' familiarity with the application itself. While the design of the DEER activity also included a preparation activity, this activity was assigned as homework, and as a result, it was not completed by all students.

6. Conclusions

This article aimed to investigate the usage of DEERs in business education, in particular in the context of ERs developed in a digital environment. Two research questions guided the study. First, how do students perceive the use of DEERs in a management course? Second, does the use of DEERs have a positive impact on the performance of students? The results showed that while students' perceptions of the use of DEERs were mostly positive and they believed that the activity had improved their mastery of the subject, there were no statistically significant differences in their performance.

ERs were originally used for recreational purposes (Nicholson, 2015). However, they have become popular in educational settings as a tool to fulfill learning objectives (Buchner et al, 2022; Taraldsen et al, 2020; Veldkamp et al, 2020). This research showed that while the improvement of educational objectives through the use of ERs is uncertain, the recreational objective of such an approach appears to be achievable. Such findings invite us to encourage further research concerning the usefulness of ERs as an educational resource to support the fulfillment of learning objectives.

Conclusions and specific recommendations can also be drawn at the level of the design and implementation of DEERs. First, instructors should carefully design a DEER to ensure its coherence with the learning objectives. Because DEER development may require specialist support, the coordination and use of graphical interfaces to understand the architecture of these rooms is encouraged. In terms of the application of DEER, instructors should consider students' levels of preparation. Accordingly, we recommend administering a tutorial or a trial test before implementing a virtual escape room during class so that the students can familiarize themselves with the immersive activity instead of being worried about potential technical issues. Ensuring that technical support and guidance is available to students during the activity is also important. In addition, the accessibility of the digital platforms for DEERs must be ensured.

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