

A pilot escape room to improve database knowledge consolidation

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Abstract

Gamification strategies have proven to be effective in increasing student engagement and improving learning outcomes. In this study, we present an escape room activity designed for a database course in the Computer Science degree at our university. It serves as an innovative approach to reinforce key concepts presented during the semester, while enjoying the challenges proposed. The concepts covered include connecting to database servers, developing SQL basic and advanced queries, and auditing. Additionally, the activity reinforces essential workplace competencies, such as teamwork and performing under pressure due to the game's countdown mechanism.

To evaluate the activity's effectiveness, we conducted a survey analyzing the students' perceptions of it, its impact on their understanding of course topics, and its influence on transversal skills such as teamwork. The results provide insights into the pedagogical value of game-based learning in database education and its potential to enhance both conceptual knowledge and professional skills.

Keywords: Databases; escape room; engagement; teamwork.

1. Introduction

In computing, technical expertise remains crucial, but it is no longer enough. Employers now prioritize soft skills, particularly collaboration and problem solving, as key to success in dynamic, multidisciplinary environments. The Organisation for Economic Co-operation and Development Learning Compass 2030 (OECD, 2019) highlights the need for a balanced skill set that integrates cognitive, social-emotional and practical skills to support lifelong learning. By fostering both technical and interpersonal skills, institutions can better prepare students to tackle complex challenges and adapt to evolving professional demands. To achieve this, higher education is moving towards active learning strategies such as flipped classrooms and project-based learning (PBL) (Rao, 2018). These methods enhance technical expertise while fostering

key soft skills. By engaging students in interactive, hands-on activities, they promote critical thinking, personal responsibility and practical problem solving, ensuring that graduates are well prepared for their future careers (Romanenko, 2024).

One particularly impactful method for fostering both technical expertise and soft skills is through the use of gamified learning activities, such as escape rooms (Borrego, 2017; Fotaris, 2019). These activities provide a dynamic and immersive environment where students must solve complex problems, collaborate effectively, and manage time under pressure to achieve a common goal. Escape rooms simulate real-world challenges by requiring participants to think critically, share responsibilities, and communicate clearly within a team. This format not only reinforces the technical knowledge taught in the curriculum but also provides a practical context for students to develop essential soft skills (Gordillo, 2024).

The objective of this paper is to describe the implementation of an escape room as an innovative learning tool in two advanced database courses of the Computer Science curriculum at the Jaume I University: Database System Design and Database System Design and Implementation. Both courses currently use the PBL methodology, developed as part of the educational innovation project "Fostering Active Learning through Computational Sustainability Projects in Advanced Database Courses". The Escape Room was specifically designed to reinforce and apply advanced database concepts through a series of interrelated tasks and activities aligned with key course topics. These activities include solving complex queries and interpreting advanced SQL operations, with each solution unlocking the next step. These challenges test students' technical skills while fostering critical soft skills, providing a hands-on, engaging and collaborative learning experience.

This work highlights the benefits of escape rooms in education, showcasing their success in fostering engagement and soft skills while preparing students for collaborative, multidisciplinary challenges. It also emphasizes the significant effort required to design detailed and well-structured activities, ensuring clarity in instructions and alignment with learning objectives. Careful planning is essential to guide students effectively, allowing them to focus on problem-solving and fully engage in the learning experience.

The main target of this work can be disclosed in the following objectives: 1) Assess if escape rooms can improve students' knowledge acquisition; 2) Enhance students' soft skills such as working in group, problem solving and leadership, and 3) Determine whether escape rooms are enjoyable and engaging for participants, beyond the learning outcomes achieved. This paper is structured as follows. This section introduces the topic and objectives of the work. Section 2 provides a detailed description of the implemented escape room. Section 3 presents the results of the activity. Finally, Section 4 summarizes the conclusions drawn from the activity and outlines possible directions for future work.

2. Escape Room

The escape room was designed and implemented with two main objectives: (1) to enhance students' learning process in advanced databases and (2) to develop their soft skills, particularly teamwork, leadership, working under time constraints and critical thinking. The activity was conducted during the 12th week of the semester, after students had completed both the theoretical content and most of the practical components of the course. Participation in the escape room was voluntary and took place during a regular two-and-a-half-hour theoretical session.

For its implementation, students were divided into small groups, simulating real-world collaborative scenarios, and tasked with navigating the escape room by applying their database knowledge to progress through the tasks.

2.1. Storyline

The storyline is based on the theft of a chemical component by a hacker and the need to identify to which warehouses it has been shipped with other labelling and in which possible shipments this component can be found.

The escape room incorporated various elements for the different challenges, including a cryptex, ultraviolet (UV) flashlights, and various types of padlocks. The clues required to solve the challenges were derived from applying the knowledge acquired in the course to the real-world scenario and others related to simple computer science aspects.

2.2. Learning activities

The technical structure of the escape room consisted of two database servers, each containing a fully populated database along with several scripts that simulated real-time interactions with the databases. These components were designed to create a realistic and dynamic environment for the participants.

Next, following the storyline, the different challenges and learning activities are described.

1. Students were required to audit a database to identify fake database connections.
 - a. Learning outcomes: 1) Establishing a database connection to an external server using its hostname and 2) Developing a SQL audit trigger to detect fake connections.
 - b. Result: the identification of the hacker and their last date of access.
2. Using the last date of access, students can open the cryptex where they can find new instructions to continue with the game. A challenge to look for the new user and password using a computer science question (translate a binary number) and the ultraviolet flashlight is included in this challenge.

- a. Learning outcomes: 1) Establishing a new database connection to an external server using the console tool and the IP and 2) Developing a complex SQL query to obtain new information about the hacker.
 - b. Result: a number to open a padlock.
3. Using the number obtained from the previous challenge, students opened a box containing additional clues, including partial information about the database model. However, key components of the model were missing. Students were then required to locate the stolen component.
 - a. Learning outcomes: 1) Analysis of design of database models to understand the relationships and dependencies between tables, 2) Developing a complex SQL query to identify the missing component, and 3) Writing an INSERT SQL query to update the database and analyzing the resulting changes.
 - b. Result: The identification (id) of the missing component.
4. At this stage, students have identified both the id of the hacker and the stolen component, so they can track the hacker's movements on the database.
 - a. Learning outcomes: 1) Writing a SQL trigger to block ships associated to the hacker and the targeted component, 2) Writing a DELETE SQL query to remove the unwanted shipments from the component and 3) Writing an INSERT SQL query to update the database and analyzing the resulting changes.
 - b. Result: a number to open the final box

This code unlocked a final box containing instructions to block a simulated “explosive”, which they needed to deactivate to successfully complete the mission.

3. Results

At the conclusion of the escape room activity, the students answered a survey we had prepared to assess students' enjoyment of the game and its perceived educational impact. The questionnaire aimed to gauge the level of engagement and motivation generated by the activity, as well as to determine whether it contributed to reinforcing key database concepts covered in the course. By collecting students' feedback, we sought to evaluate the effectiveness of the game-based learning approach in enhancing their understanding of fundamental theoretical and practical aspects of database management.

In addition to course-specific learning outcomes, the survey also explored the impact of the game on transversal competencies fostered through the activity. Specifically, we investigated improvements in skills related to teamwork, which is essential for academic and professional success. By analyzing the students' responses, we aimed to determine whether the escape room format effectively facilitated the acquisition of both technical knowledge and transferable skills.

The survey included several questions where different answers were offered (we indicate them in parenthesis in the following list) regarding their perspective of the experience, and its impact in the course contents and teamwork:

1. How many escape rooms had you played before today's activity? (None; 5 or less; more than 5)
2. Did you enjoy the activity? (I didn't like it at all; I liked it a little; I felt indifferent; I liked it; I liked it a lot)
3. Would you like to have more activities like today's in this or other courses? (I don't want to do anything like this again; I would rather not have more activities like this; I don't mind/I'm indifferent; I would like to; I would love to)
4. Do you think the game helped you better assimilate the course concepts? (No, I was focused on the game; Yes, but only in very few aspects; Yes, in all those covered in the game)
5. Mark the concepts that became clearer to you after playing the game (Access to database servers; SELECT, INSERT, and DELETE statements; Table creation; Trigger creation; Auditing)
6. How was your experience working in a team? (I didn't like it at all; I liked it a little; I felt indifferent; I liked it; I liked it a lot)
7. How would you rate your participation in the team? (Not active at all; Slightly active; Moderately active; Quite active; Very active)
8. How would you rate your teammates' participation in the team? (Not active at all; Slightly active; Moderately active; Quite active; Very active)

Figure 1 illustrates the results for the questions related to escape room itself; a total of 35 answers were collected. Regarding the students' experience of such games, more than 60% of them (see Figure 1 top left) had played an escape room at least once (which indicates that they are interested in such games), and more than 90% of them stated that they had fun playing (see Figure 1 top right) and would like to have similar activities on other courses (see Figure 1 bottom left). Regarding the course concepts involved in the game (see Figure 1 bottom right), except for one student, all agree that the game contributed to clarifying them, either in all the aspects covered (63%) or at least in some (31%).

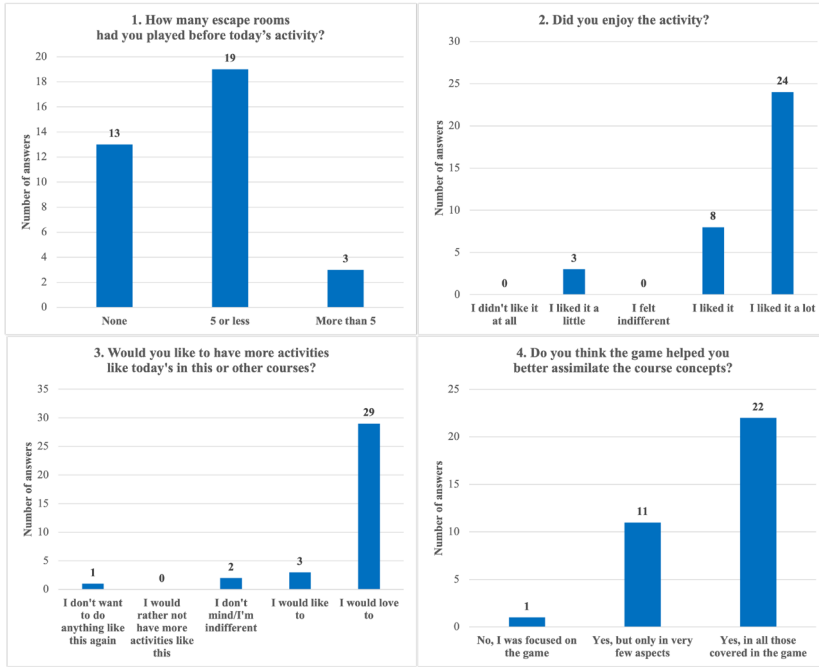


Figure 1.- Results associated with the survey questions.

Figure 2 presents the results considering the traversal teamwork skills, concretely improving their contribution degree (74%), their attitude (80%), responsibility (69%), leadership (69%), communication (77%), and conflict resolution (77%). Besides, more than 70% recognize they have actively participated in the game, and 91% affirm the same regarding the involvement of the other members of their team.

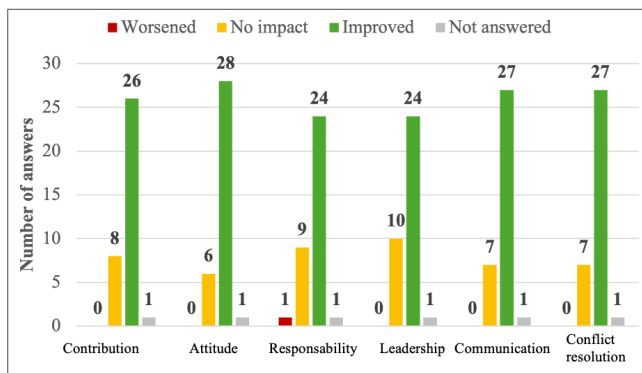


Figure 2.- Impact of the scape room in teamwork skills

Finally, Figure 3 is focused on questions related to the participation of students in team .Considering the different database related concepts addressed in the game (see Figure 2 top left), the auditing was the one that benefit more (71% of the students understood it better thanks to the game), and the table creation was the least benefited (48% of the students understood it better thanks to the game), which is reasonable considering the complexity of the auditing compared to simply creating tables. Around 60% of the students said that they improved on accessing database servers, using statements such as INSERT, SELECT, and DELETE, and creating triggers.

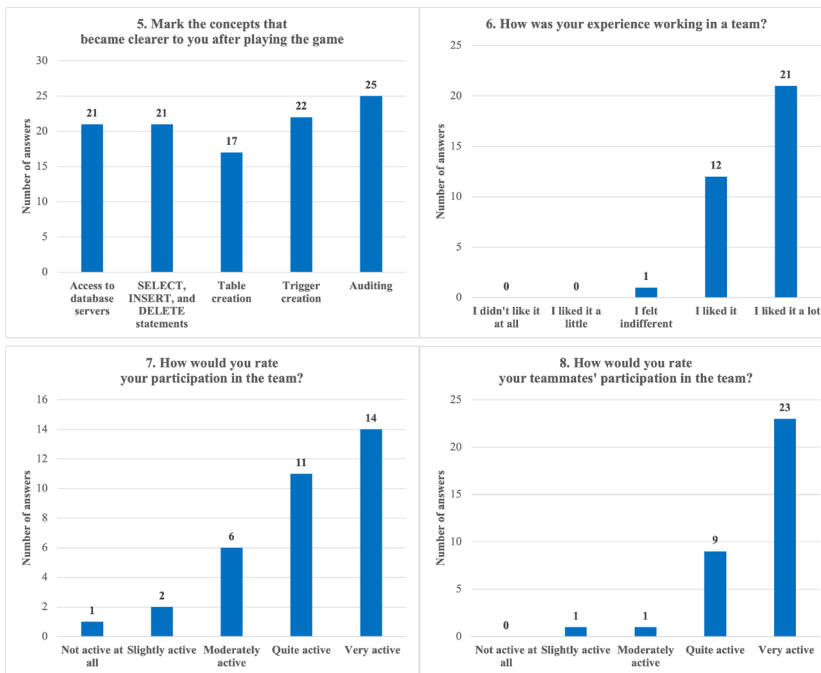


Figure 3.- Results associated to the Escape room results and team performance.

4. Conclusion

Using escape rooms as a learning activity has proved to be a useful tool to promote the students' engagement and actively contribute to their knowledge consolidation. Moreover, transversal competencies highly valued at the labor market, such as teamwork, leadership skills, working under time constraints and critical thinking are reinforced. In the particular context of the database courses, this activity has successfully combined the learning outcomes pursued regarding the theoretical and practical contents, with the dynamics typically employed in escape rooms to design the challenges, such as padlocks and cryptex. The students' opinions reveal that they both enjoyed the game while improving knowledge of the targeted concepts.

These positive results have encouraged the teachers to continue using the escape room as a teaching activity. For this reason, we are working on the development of an escape room for another subject, as well as on the creation of guidelines for the use of escape rooms as a teaching activity.

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References

- Borrego, C., Fernández, C., Blanes, I., Robles, S. (2017). Room escape at class: Escape games activities to facilitate the motivation and learning in computer science. *JOTSE*, 7(2), 162-171.
- Fotaris, P., Mastoras, T. (2019).Escape rooms for learning: A systematic review. *Proceedings of the European Conference on Games-based Learning*, 2019-October, pp. 235 – 243. doi: 10.34190/GBL.19.179
- Gordillo, A., López-Fernández, D. (2024) Are Educational Escape Rooms More Effective Than Traditional Lectures for Teaching Software Engineering? A Randomized Controlled Trial. *IEEE Transactions on Education*, vol. 67, no. 5, pp. 660-668, Oct. 2024, doi: 10.1109/TE.2024.3403913.
- OECD (2019). Future of education and skills 2030. *OECD learning compass 2030*.
- Rao, P. R. M., Chugh, K. L., Prasad K. S., Shekar. K. (2018). Impact of Active Learning in Engineering Education. In: *IEEE 6th International Conference on MOOCs, Innovation and Technology in Education (MITE)*, Hyderabad, India, doi: 10.1109/MITE.2018.8747038.
- Romanenko, Y.N., Stepanova, M., Maksimenko, N. (2024). Soft skills: students and employers crave. *Humanit Soc Sci Commun* 11, 931. <https://doi.org/10.1057/s41599-024-03250-8>