

Game-based learning to promote student engagement: an escape room on databases

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Abstract

The use of game dynamics in the academic environment has proven to be highly motivating for students. This paper focuses on an Escape Room game developed in a database subject to cover several objectives: to integrate contents in a single activity, to encourage group work, to increase student engagement and to promote a playful environment for proficiency testing.

The experience is evaluated by means of a survey in which students are asked about the degree of achievement of different objectives such as the improvement of learning, reflection on their own learning (metacognition) or their engagement and motivation. The analysis of the data collected reveals a high degree of acceptance of the activity among the students, so another objective of the work is to describe the implementation of the activity as well as to provide some tips that can be useful to adapt this type of game to other university subjects.

Keywords: *gamification; student motivation; database teaching; new teaching experiences.*

1. Introduction

Game-based learning is based on the incorporation of game techniques and dynamics in the classroom to improve aspects such as performance, engagement, motivation and, ultimately, the learning of specific content.

According to Kim (Kim, B. 2015) the term gamification was coined by Nick Pelling in 2002 and started to be frequently used in 2010. Gamification (Deterding et al. 2011) can be defined as the use of strategies, models, dynamics, mechanics and game elements in non-game contexts, with the purpose of transmitting a message or content or changing behaviour, through a playful experience that encourages motivation, engagement and fun. Therefore, gamification is not creating a game but transferring the positive characteristics of a game to something that is not. In general, gamification strategies promote intrinsic motivation, often including elements such as the setting of challenges, the use of a reward system and voluntary participation, which has a very positive effect on increasing the learner's personal effort, collaboration with peers, engagement with the group and with their own learning, and building self-confidence.

There are a multitude of games that can serve as inspiration to carry out a gamified activity. Cobos (Cobos et al. 2018) proposed and described a set of games used in different university subjects, some of them adapted from famous TV quiz shows.

One type of games that young people currently prefer are strategy games (Miranda, J. M. G. 2013). , among which Escape Rooms are classified. An Escape Room is a very popular game that consists of locking a group of players in a room with a time limit to solve an enigma that allows them to get out of the room (Boix et al. 2019). The use of Escape Room in a learning context is not new, several authors have reported their teaching experiences with this type of activity (Boix, 2019; López-Gómez et al. 2020): from activities where a live Escape Room is played where participants must find clues hidden in physical objects in the place where it takes place (classroom, library, campus, etc.) to others where the experience is virtual, which implies the creation of digital resources for this purpose.

In our case, the activity is proposed for a second subject on databases named Data Management, which is taught in the second year of the degree in Data Science .The format adopted for the game will be digital but it will take place in the physical classroom, face-to-face, which favours companionship, interaction between participants, close contact with the teaching staff and agility in the resolution of doubts by the team of teachers, among others.

Unlike other similar experiences such as those mentioned above, our objective is mainly playful and non-evaluative, trying to increase student and teacher satisfaction by implementing a striking game that transmits the attractiveness of the subject itself, without

requiring excessive effort on the part of the teachers. In addition, the implementation of such an activity within a database subject will allow us to fulfil other important goals:

- Integrating the different parts of the subject in a single activity. In a course where different technologies or topics not intrinsically linked are explained, this activity helps its integration within the subject. This subject deals with new models of databases generally known as NoSQL, and tools and techniques for data warehousing and multidimensional data models. It also presents an overview of data integration and migration processes.
- Presenting databases as a challenge from which to extract relevant information. The subject of databases deals with the organisation, management and manipulation of data of various kinds, so it is a good example of how to put into practice what has been learnt by using databases with a certain appeal.
- Encourage group work. The escape rooms are games with collaborative dynamics, so the participants must get involved in order to “all get out” or “none of them”.
- Promoting a playful environment for proficiency testing. An informal atmosphere allows students to put into practice the skills acquired during the course, without the fear of not knowing.
- Encouraging innovative thinking (“think out of the box”), by incorporating informal elements and typical Escape Room puzzles into the game.

The paper is structured as follows: section 2 describes how the activity has been designed, detailing aspects such as the creation of the story, the graphical interface, the databases used, the incorporation of clues and other informal elements that help to capture the attention of the learner as well as other aspects related to its integration within a learning platform. Section 3 presents how the activity took place, section 4 shows the results by means of the analysis of the survey answers and finally, in section 5, conclusions are drawn.

2. Design of the activity

This section explains how the Escape Room “Aces of Databases” has been designed on the basis that motivating activities must have a sense of unity, be varied, be perceived as useful and include feedback (Hackman et al., 1976) .

2.1. Storyline and structure

A fundamental part of any Escape Room is the story into which the different puzzles/enigmas will be integrated. It is important that the storyline, which will be the common thread of the activity, is interesting for the audience. A simple way to achieve an attractive storyline is to take inspiration from a novel or a film. In our case, the delirious comedy *Top Secret*, filmed in 1984, has been used for this purpose.

In our linear Escape Room, the whole story is divided into episodes. Each of these episodes tells a part of the story and includes several puzzles to pass in order to advance in the game: the solutions to the individual riddles are combined in a certain way to form the key to move on to the next episode. Most of these riddles, in each episode, are related to each other and can be solved thanks to what has been learned in the databases subject.



Figure 1 Example episode showing the narrative used (a) together with some clues (b).

Figure 1 shows two opening scenes of the game: figure 1.a displays the introduction to the story and the presentation of characters while figure 1.b shows some of the puzzles to be solved. When all the puzzles in an episode have been correctly solved, instructions are given to compose the key to access next episode by clicling the key icon (figure 1.b).

This graphical interface has been designed by means of the Genially tool, which allows the creation of visually attractive and original contents by inserting diverse elements such as images, videos, audios, animations and also allowing user interaction. In addition, this tool has the advantage that it is easy to use and that the created content is shared via a web URL, which facilitates its integration into learning platforms.

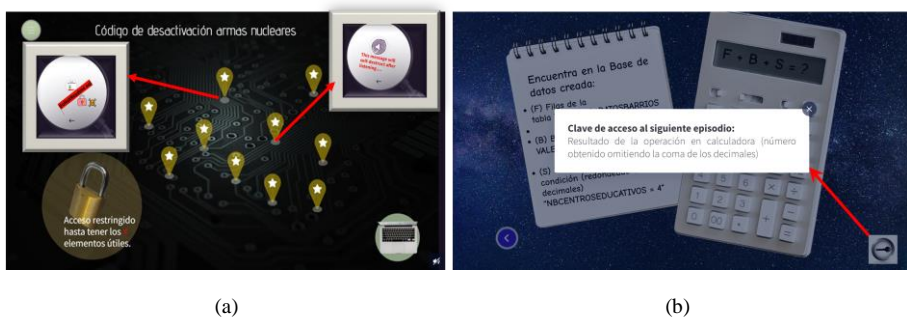


Figure 2: Interactive contents included..

Figure 2 shows the interactive content introduced in another of the episodes: in the image (figure 2.a) there are several bright dots corresponding to areas to explore in order to find new clues to solve the following riddles; when these elements are clicked other hidden

elements become visible. The red arrows indicate the pressed items that activate the display of the highlighted elements. All episodes feature a key (figure 2.b) icon that displays the message of how to compose the code that will give access to the next episode. The contestants receive the appropriate feedback on their work when they enter the requested code, since it allows them to progress in the game or not.

2.2. Interesting Data, Open Data and Non-academic issues

One way to make the activity useful and meaningful is to make use of real data from which to draw interesting conclusions. For this purpose, geographical (e.g. country, city features), climatic or epidemiological databases can be used. There are public organizations that provide very interesting data collections that can be used to motivate students. In this activity different database systems (SQL and NoSQL) have been utilized, many of them come from the open data repository of the City Council of Valencia. Specifically, this repository has socioeconomic and demographic data by neighbourhoods (schools, kindergartens, medical centres, air quality, bicycle usage, age of residents, etc.).

On the other hand, the significance of any activity also depends on its relation to reality. Therefore, in the game it is not only recommended to use real data, but also to force them to connect with reality beyond the purely academic. For example, if a clue leads to a country, the required key may be the international telephone prefix of that country, data that you will be able to find through the usual web search engines. Likewise, something can be asked related to movies or TV series that are to the taste of the majority. In addition, it is highly recommended to include a physical activity, which involves getting away from the computer to observe something of the real world with the purpose to enhance the gaming experience. Figure 3 shows other kind of riddles, not directly linked with the academic subject.



Figure 3: Non-academic riddles

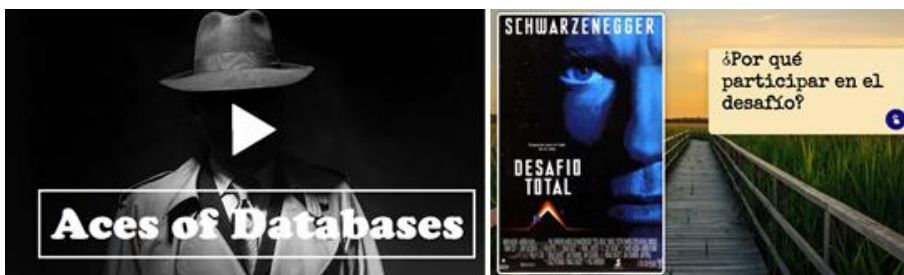
With all these ingredients, an activity is achieved that stands out for the variety of different types of puzzles used and that manages to link what has been learnt in the subject of databases with their usefulness in real life through collections of interest data.

3. Activity development

The activity was planned as a face-to-face activity (although it can be adapted to be carried out virtually) during a 2 hour session. For an Escape Room without physical objects, ICT support is necessary to create the content of the escape room, provide the instructions, control and monitor the progress and receive a final report. All these actions can be carried out from the learning platform, Moodle in our case, in conjunction with URL-accessible Genially contents, so the whole activity was integrated within this platform, which favours coherence with the rest of the subject.

The activity is presented to students on a voluntary basis, but for the activity to be successful, a high level of participation must be achieved. With this objective in mind, in addition to the material for the development of the activity, attention was paid to the development of additional material to encourage participation:

- a video (figure 3.a) has been created, in which the activity is shown as a challenge to demonstrate the skills acquired and their detective attitudes.
- an engaging presentation (figure 3.b) was designed, summarising all the reasons for taking part in the challenge: from academic incentives to prizes sponsored by the Chair of Gamification and Open Government of Valencia City Council.



(a) (b)
Figure 4: video and motivating presentation

The activity is carried out in groups, encouraging collaborative work and the sharing of roles. During the development of the activity, each team works autonomously, with minimal help from the lecturer. This requires that all the material and instructions provided are unambiguous and complete: all the resources that make up the activity should be thoroughly checked. It is also important that no group gets discouraged during the development, so additional hints were planned for the first episodes, provided periodically during the game, to help them to advance if they get stuck.

In this first edition, 75 students participated, grouped into 21 teams, of which only one team managed to beat the challenge. It is convenient that at least one group completes the game, so the difficulty must be well measured so that it is feasible to solve it in the established time.

The activity ends with the presentation of the teams' results, in which the good work done by the teams that have managed to overcome the challenge is acknowledged (figure 4). This element of positive feedback is very beneficial for these successful groups.



Figure 5: Escape room development

4. Results

The evaluation of the experience was carried out by means of a survey to find out the students' opinion. The survey is filled in voluntarily after the activity and includes 8 questions in which they have to mark the option that most closely matches their perception on a Likert scale from 1 to 5 (from Strongly Disagree to Strongly Agree), and other open questions (What did you like the most? What did you like the least? What improvements would you suggest?). Table 1 shows the average score of the 28 responses collected.

Table 1: Questions in the survey and average points

	Question text	Average
1	The activity has helped me to learn the contents of the subject.	3,9
2	The activity has helped me to reflect on my own learning.	4,0
3	The activity has helped me to increase my involvement in the subject.	4,1
4	The activity has helped me to increase my motivation	4,0
5	I enjoyed the activity	4,1
6	The general difficulty of the activity seemed to me to be in line with what I have worked on in the course.	3,9
7	The organisation of the activity was correct	4,0
8	I would like a similar activity in other subjects	4,2

The student ratings for each of the questions show that 6 out of 8 questions score 4.0 or higher. The statement with which they agree the most is number 8 "They would like a similar activity in other subjects", and those with the lowest average score are number 1 and 6. In all questions, at least 75% of the students give a score equal to or higher than 4 on the Likert scale (between 1 and 5), which implies very high student satisfaction. In the open questions, they mainly indicated novelty, fun and motivation as positive aspects. As for the negative aspects, they mentioned the pressure of limited time, the degree of difficulty and, in some cases, the complication of understanding the issues raised in non-academic terms.

5. Conclusions

An Escape Room game developed in a database course has been described in detail. The results of the survey show that the experience was satisfactory for the students. It was also rewarding for the teaching staff, both for the novelty of creating an activity in a different format and with a different purpose than usual, as well as for the good reception. However, the design and preparation was quite laborious, at least in its first edition, and the importance of a careful and complete organization for its success should be emphasized.

The experience has also helped teachers to appreciate the convenience of giving a greater sense of unity to the different activities taught in a subject. As future work, it is intended to improve this experience and help its expansion to other subjects.

Acknowledgments

This work has been possible thanks to the help granted by the Universitat de València (Servei de Formació Permanent i Innovació Educativa) in the context of the project UV-SFPIE_PID-1642016.

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