

DESIGNING A BIOCHEMICAL ESCAPE ROOM FOR UNDERGRADUATE STUDENTS

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Abstract

Gamification is increasingly used in Higher Education to foster intrinsic motivation of undergraduate students. In this sense, we designed the Biochemical Escape Room. The students, organized in teams and through the overcoming of challenges, tackled the contents reviewed in the face-to-face classes. In addition, the tests helped in the training of different soft skills such as creative thinking, deductive thinking, collaborative work, teamwork, manual dexterity, communication and time management. The activity was designed in several phases: i) setting the learning objectives; ii) adapting the physical spaces to the teams involved in the "game"; iii) acquiring the material; iv) preparing, placing the tests and the clues and general rehearsal before D-day; and v) D-day. The results obtained after the design of the Biochemical Escape Room and its implementation show that one of the objectives of the activity had been achieved: it provided an "injection" of motivation for teachers and students. And although there are certain aspects that need to be improved, designing the escape room for the biochemistry laboratories has meant a significant change both for the instructors, in the way we teach, and for the students, in the manner they learn.

Keywords: Gamification, challenge-based learning, escape room, Biochemistry, soft skills.

1 INTRODUCTION

The implementation of game dynamics in the educational environment provides numerous advantages [1]: i) it increases students' motivation and self-motivation; ii) it makes the contents more attractive; iii) it favours active learning and knowledge assimilation; iv) it stimulates concentration; v) it improves performance; vi) it favours teamwork; and vii) it helps to exercise logic and strategy.

In this sense, Escape Room-type games have been used in Higher Education in recent [2-5]. In this way, students are more actively involved in their learning, as opposed to the classical teacher-centered approach. Instructors who have used this type of games highlight their valuable usefulness, as they allow students to acquire and apply the knowledge reviewed in the subject as well as develop many other competences and enhance different skills. In addition, it allows the instructor to witness *in situ* the students' reasoning/deduction process and the selection/handling of information sources, aspects of enormous value for improving the teaching-learning process [6, 7].

The objective of the activity developed was to promote meaningful learning and student motivation, taking into account the benefits of "game-based" learning, its popularity and the rapid expansion of Escape Room-type games among the general population because of the challenge they provide. Hence, this work details the design of the escape room that we carried out in the biochemistry laboratories.

2 METHODOLOGY

The activity carried out focused on learning based on challenge games with first year undergraduate students. It was carried out with half of the students cohort (n=47) enrolled in the Biochemistry subject. This allowed us to have a perception, although preliminary, of the learning benefit by comparing it to the other half. The students were divided into teams of eight students organized in four couples.

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2.1 Setting the learning objectives

The tests that students should go through were designed in alignment with the learning objectives of the Biochemistry practical. An outline of each of the learning objectives was drawn up and a specific Escape Room test was associated to it.

In order to achieve the objectives set, the students had to pass thirteen challenges in a collaborative manner. These challenges included manual dexterity, calculation and communication abilities related to the theoretical and practical foundations of the subject.

2.2 Adapting the physical spaces to the teams involved in the "game"

Secondly, it was important to find the physical space in which to carry out the "game". The students in each laboratory (n=24) "competed" by organising themselves into three teams. Each team was assigned an instructor who monitored the team's performance and, using the team control sheet, recorded the existing penalties and the appropriate observations during the Escape Room. To facilitate the dynamics of the game, a specific colour (blue, yellow or red) was assigned to the team and the worktables (Fig. 1). The clues in coloured envelopes were distributed around the laboratory.

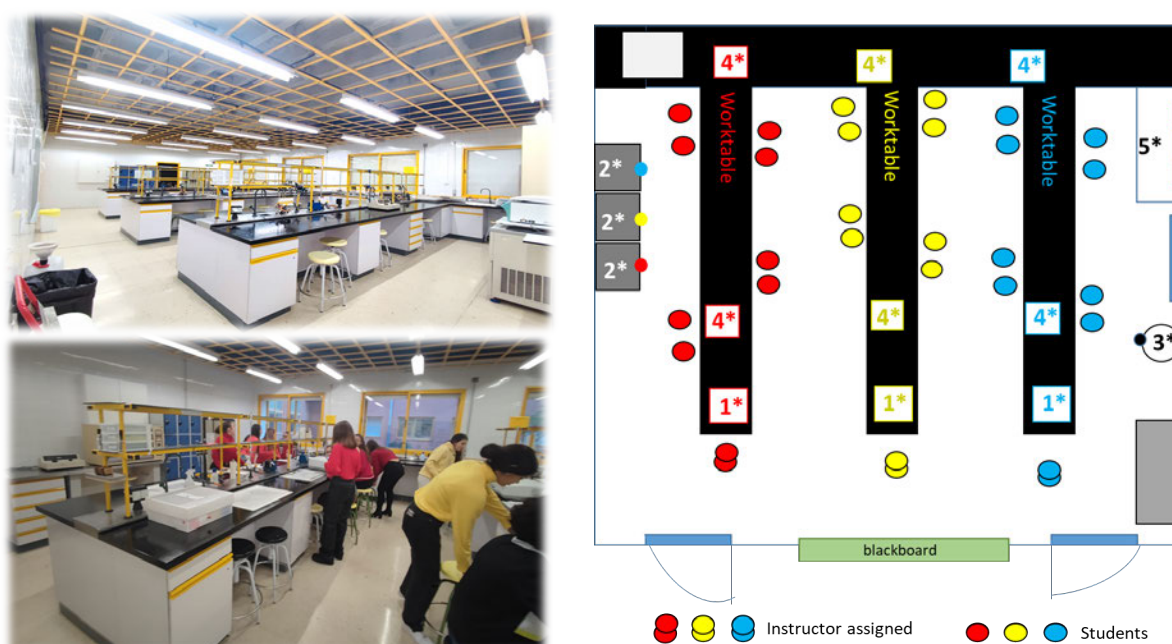


Figure 1. Physical space where the biochemical Escape Room took place. Left: top, the biochemistry laboratory; bottom, detail of the red team's worktable. Right: diagram of the distribution of the teams at the worktables. 1, each team's escape room kit locked with key padlocks; 2, lockers locked with padlocks with secret numbering; 3, distilled water canister; 4, spectrophotometers used in the escape room; 5, chemical fumes hood. *, examples of the locations of the coloured envelopes containing the clues.

2.3 Acquiring the material

In addition to using specific equipment (e.g. spectrophotometer) and basic laboratory material (e.g. a set of automatic pipettes), the "game" incorporated messages with secret codes or invisible ink, mirror messages, padlocks that could be unlocked with a key or with a numerical code, among others. For this purpose, elements such as coloured envelopes, mirrors, magic boxes that were difficult to open, invisible ink markers, red filters, safes, etc. were needed, which were acquired for the development of the activity.

For each team, we incorporated these elements in a box locked with a keyed padlock (Fig. 2). The so-called escape room kit included the necessary elements to carry out the activity successfully (Table 1).

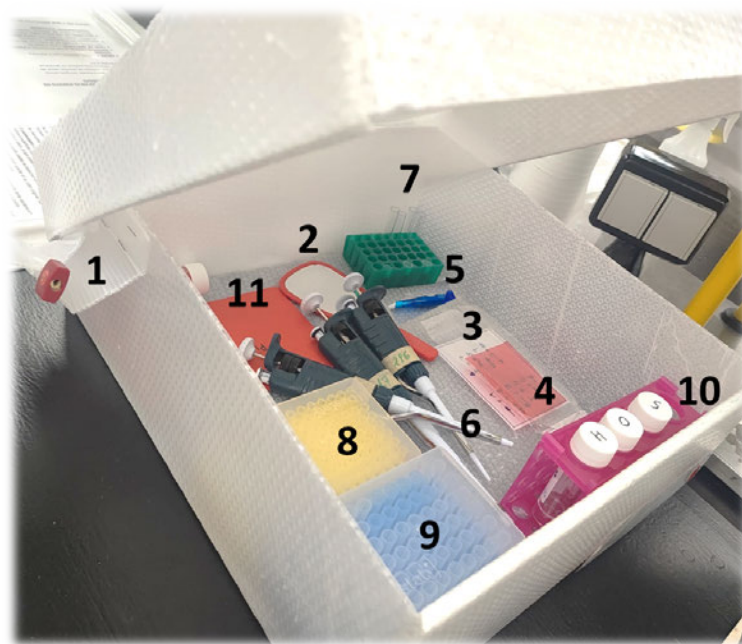


Figure 2. Contents of the biochemical escape room kit locked with key padlock (1): 2, mirror; 3, symbol code card; 4, red gel filter; 5, ultraviolet light torch; 6, set of automatic pipettes; 7, rack with test tubes; 8, box of yellow tips; 9, box of blue tips; 10, tubes with coloured solution; 11, coloured envelope with the hint #01.

Table 1. Tools and elements included in a box or escape room kit locked with a key padlock and the role of each one of them in the development of the game.

<i>Tools and elements</i>	<i>Function</i>
Mirror	Decoding mirror image message
Code card with symbols	Resolving message with symbols
Red transparent gel filters	Discovering hidden words
Ultraviolet light torches	Decrypting messages with invisible ink
Set of three automatic pipettes	Performing the manual volume challenge
A test tube rack	
A box of yellow tips	
A box of blue tips	
Tube with coloured solution	
An envelope with clue #1	Continue with the game

It was also necessary to contextualise the game, the existence of a scenario. To do this, we created a message containing the guidelines, rules and time limit. In addition, there was a first challenge of the game; if successfully completed, it provided the key that unlocked the biochemical escape room kit (Fig. 3).

A key element that we, the instructors, had to have at all times during the game was what we called a team control sheet. This sheet contained basic information about each team: the laboratory where the game was being played the number of students per team, names of the couples, spokesperson and observations. In addition, it contained the different clues and challenges to be performed organized in a column, to mark the corresponding penalties if the tests had not been passed properly (Fig. 4).

1 Today, due to a technical problem, all the entrances and exits to the Medicine building have been blocked and communication with the outside has been compromised. Faced with this situation, the caretaker, Pepe, began to feel unwell. He was off duty. His colleague got scared. When asked by his colleague, Pepe said that "he hadn't eaten anything and that he has had some sugar problems for more than four months". There is no one in the building, just you. You are the only ones who can find out what is wrong with Pepe and give him the help he needs..

2 **Guidelines and Rules**

- You are the BLUE/YELLOW/RED team. You will have 50 minutes to find clues in envelopes of your colour and carry out tests to help Pepe.
- One spokesperson per team will be appointed.
- You will have to pass 13 challenges.
- You will work collaboratively.
- When indicated, couple tests will be carried out. All couple must be responsible for two tests.
- There will be time penalties for wrong answers.
- A mobile phone will be used to keep track of the time and another mobile phone will be used to record the answers.
- Each team will be assigned a responsible instructor who will keep track of the answers and the time taken to complete the tests and penalties (team control sheet).

3 Let's get started. You must find a discordant element in the Biochemistry laboratory. Inside you will find the key to the box in which you have all the material you need to "escape".

Figure 3. Initial message provided to each team.
1, scenario; 2, guidelines, rules and time limit; 3, first challenge.

TEAM CONTROL SHEET

Nursing Escape Room		Laboratory	Observations
Date			
Number students/team			
Couple			
Spokesperson			
Clues	Challenges	Penalties	Observations
#0	Scenario	5 min <input type="checkbox"/>	
#1	Answer question Test Couple #1-Communication		
#2	Answer question Find clue	5 min <input type="checkbox"/> 3 min <input type="checkbox"/>	
#3	Find clue	5 min <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 3 min <input type="checkbox"/>	
#4	Test Couple #2-Manual dexterity		
#5	Find clue Test Couple #3-Calculation		
#6	Answer question Find clue	5 min <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 3 min <input type="checkbox"/>	
#7	Answer question Test Couple #4-Communication	5 min <input type="checkbox"/>	
#8	Find clue Test Couple #5-Calculation		
#9	Answer question Find clue	5 min <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 3 min <input type="checkbox"/>	
#10	Test Couple #6-Communication		
#11	Test Couple #7-Calculation	5 min <input type="checkbox"/>	
#12	Find clue		
#13	Test Couple #8-Communication Solve puzzle		
TOTAL PENALTY TIME			

Figure 4. Team control sheet.

2.4 Preparing, placing the tests and clues and general rehearsal

The preparation of tests and clues, their location and the rehearsal before D-day was the most creative and exciting phase for the instructors (Figs. 4 and 5). The challenges were designed taking into account the students' deductive thinking, manual dexterity and problem solving skills in mind.

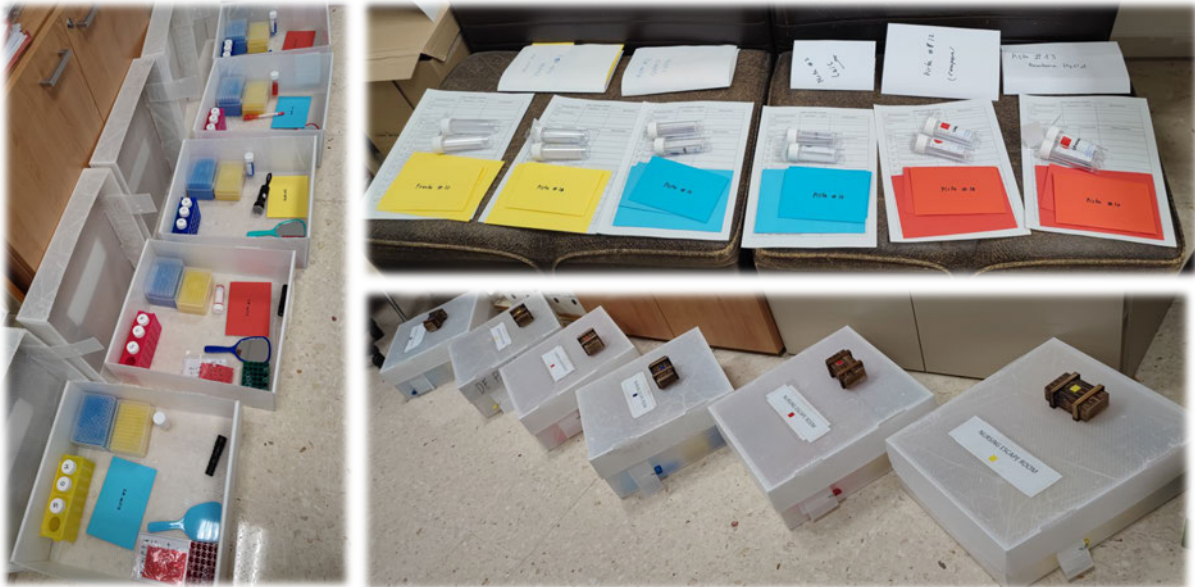


Figure 4. Material prepared for the execution of the biochemical escape room.

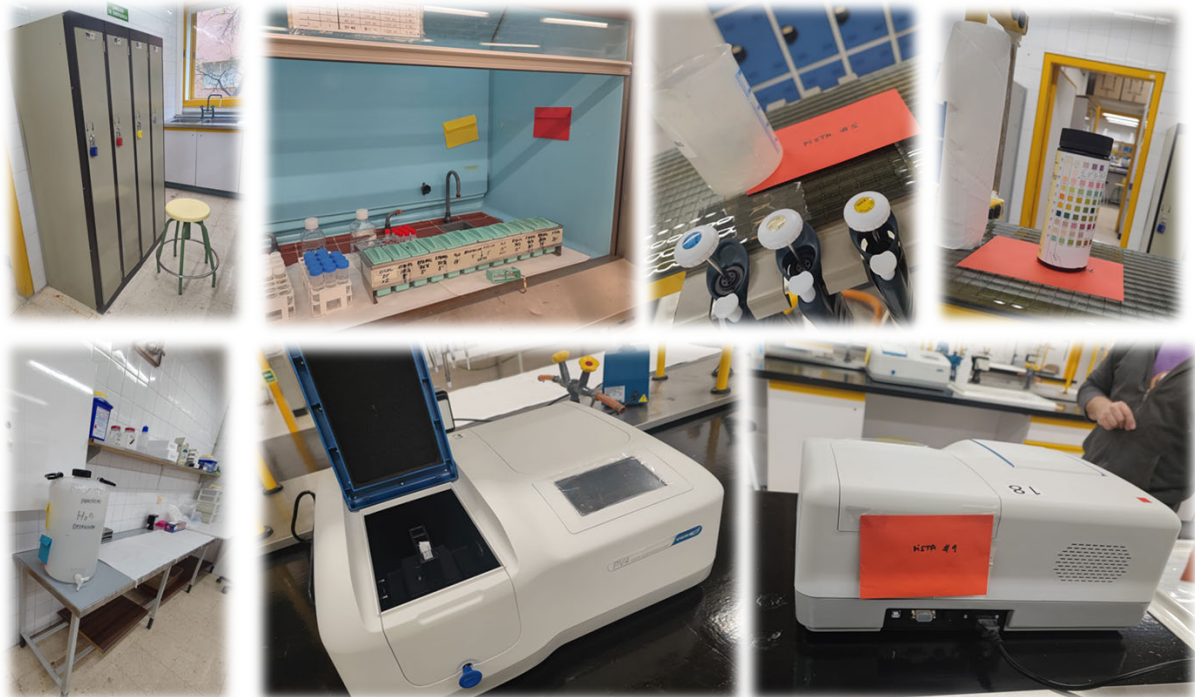


Figure 5. Location of the different hints in coloured envelopes or on the equipment in the Biochemistry laboratory.

Once the clues had been placed in the different locations, we had to do a rehearsal to check that the game was going to run properly. For this purpose, we went through all the steps of the Biochemistry Escape Room with a summary sheet we prepared for the instructors.

2.5 D-day

The students did not know what they would be doing at the end of their practical laboratory sessions in Biochemistry. They had been warned that they should wear clothes with the colour assigned to each team. Likewise, the instructor in charge of each team had to wear the same colour.

Among the teachers involved, there was a climate of excitement, emotion, nervousness and a certain amount of insecurity. We had not carried out an action like this previously, so we had no reference regarding the students' response.

The students were expectant just before we explained to them what they would be participating in. As soon as we revealed the existence of the escape room and its objective, they showed their motivation to carry out the game that would help them understand the contents reviewed in their classes (Fig. 6).



Figure 6. Images of the tests carried out by the winning team in the biochemical escape room.

3 RESULTS

On D-day, just before learning that they would be participating in the Biochemical Escape Room, the students were excited and enthusiastic. When they found out, it was excitement and motivation that they expressed. The game went very smoothly. However, there were a couple of mistakes, in a puzzle and in the symbol code, which we have to correct for future editions.

In relation to the tests carried out and the weakness found in the students, we consider that we must change certain aspects of the teaching-learning process in order to pursue meaningful learning in our subject.

4 CONCLUSIONS

We consider that the design of the Biochemical Escape Room has been an experience that has led to significant learning and, in turn, has trained different soft skills (creative thinking, deductive thinking, collaborative work, teamwork, manual dexterity, communication and time management) in our students.

Thus, participating students: i) overcame small challenges in a given time (challenge-based learning); ii) used the game to learn (gamification); iii) worked in teams, where they had to cooperate and dialogue (cooperative work); iv) were responsible for certain challenges (initiative); v) went over tests with codes and puzzles (multiple intelligence); vi) related what was covered in the game to the content reviewed in class. All of this was aimed at fostering meaningful and lasting learning.

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