ISBN: 978-628-96613-3-0. ISSN: 2414-6390. Digital Object Identifier: https://dx.doi.org/10.18687/LACCEI2026.1.1.1759

# Design, implementation and evaluation of an escape room as a didactic strategy in the teaching of food preservation methods

Paulina Torres Castro[1]; Natalia Calderón Chango[2]
[1]Escuela Superior Politécnica del Chimborazo, Ecuador, *mariap.torres@espoch.edu.ec*
[2]Instituto Superior Universitario Sucre, Ecuador, *ncalderon@tecnologicosucre.edu.ec*

***Abstract*– Educational escape rooms or breakout activities aim to promote learning and the application of classroom- acquired knowledge through a playful methodology based on the resolution of riddles, puzzles, and progressive challenges oriented toward solving a given problem. The objective of the present study was to design, implement, and evaluate an educational escape room for students enrolled in the Preservation Methods course within the Food Processing Technology degree program. An escape room entitled "Escapa del Lab" was designed, with challenges planned according to the expected learning outcomes of the course. The activity was implemented with students who had passed the course during the October 2024–February 2025 academic period and with students enrolled in the September 2025–January 2026 period. The educational experience was evaluated through students' perceptions using the Gameful Experience Scale (GAMEX), as well as through a comparative analysis of academic grades among the study groups. The results showed a positive evaluation of the escape room, reflected in high scores in the dimensions of enjoyment, activation, and overall gameful experience. However, no statistically significant differences were observed in academic grades between the evaluated groups. In conclusion, the escape room represents an innovative and well-accepted pedagogical strategy that enhances the educational experience and student motivation, although its impact on academic performance was not significant in the short term.***

***Keywords*-- Escape room; educational gamification; higher education; food preservation methods.***

## I. Introduction

Active learning methodologies are one of the best tools for engaging students in their own learning processes [1].

Gamification and educational escape rooms are learning tools that use game strategies in a non-game context to learn or reinforce key concepts from various subjects and fields of knowledge [2].

Among the advantages offered by gamification are its adaptation to different learning styles, the possibility of making mistakes, immediate feedback, and the development of creativity, as well as increased student motivation and socialization. Disadvantages include the risk of excessive competitiveness and inadequate time management, aspects that should be considered along with other specific characteristics of each game [3].

On the other hand, escape rooms represent a form of gamification that combines narrative, time pressure, collaborative problem-solving, and immediate feedback in an immersive learning environment [4]. Furthermore, they foster transversal skills such as teamwork, leadership, creative thinking, and communication; they are versatile and can be adapted to various subjects and content [5,6].

To ensure the successful implementation of an educational escape room, it is essential to consider several key elements. First, it is important to understand the different types of students and properly define grouping criteria so that individual characteristics complement each other and foster effective cooperative learning [6]. In this regard, there is the validated "Hexad User Types Questionnaire," an assessment tool that allows for the classification of individuals according to six types of "players" or motivations (philanthropist, socializer, free spirit, achiever, player, and disruptor), widely used in educational gamification, experience design, and game-based learning [7].

Likewise, the time required to develop the experience must be carefully planned, ensuring that the proposed activities and challenges present an appropriate level of difficulty: neither too simple nor too complex, adapting to the level and pace of the participants [6].

Another crucial aspect is the clear definition of the learning objectives, which should guide both the design of the tests and the game's narrative. This narrative should be engaging, relevant to the thematic content, and consistent with the available physical space, which can be enhanced through elements such as decoration, lighting, or ambient music [6].

Puzzles and challenges form the core of an escape room, so they must be creatively designed, aligned with academic content, and geared towards fostering critical thinking, collaboration, and problem-solving. It is also essential to determine in advance the technology and materials to be used, as well as the assessment approach, especially if the activity will be part of a grade or if its purpose extends beyond simply reinforcing the content [6].

Finally, it is recommended to conduct at least one trial run without the students present to verify that all the puzzles function correctly, that the narrative flows smoothly, and that the estimated times are appropriate [6].

The subject of Food Preservation Methods is a fundamental component of Food Engineering and Technology programs. However, despite an exhaustive search of various scientific databases, no published studies were identified documenting the application of educational escape rooms specifically designed for teaching food preservation methods.

Nevertheless, this type of resource has been used in diverse educational settings and at all levels of education [8].

Several studies have shown that implementing escape rooms in educational contexts can improve students' academic performance [9], increase course pass rates [10], and strengthen performance on subsequent assessments. Furthermore, it is a valuable tool for developing soft skills, as it promotes active learning, critical thinking, problem- solving, and teamwork [11].

On the other hand, the validated GAMEX scale is a measurement instrument designed to capture the emotional and engaging dimensions of gamification. This scale helps determine whether gamification strategies are effective, particularly in generating gameful experiences among participants using gamified applications. Moreover, the instrument comprises items that are easy to understand and can be adapted to various contexts and different types of gamified applications [12].

In this context, the research question guiding this study is: How can an educational escape room be designed, implemented, and evaluated for teaching preservation methods? Although several studies have described the processes involved in the design and implementation of educational escape rooms [13,14,15,16], many highlight the challenges associated with evaluating these types of experiences. Therefore, the present study aims to design, implement, and evaluate an educational escape room for students enrolled in the Preservation Methods course within the Food Processing Technology degree program. For this purpose, validated instruments such as the HEXAD scale (for implementation) and the GAMEX scale (for evaluation) were employed.

TABLE I
PEAK TABLE

| P | C | O | C |
|---|---|---|---|
| Problem | Comparison | Results | Context |
| Teaching | Educational Innovation | Learning/ Experience | Educational Process |
| **PI:** How can an escape room be designed, implemented, and evaluated as a teaching strategy for food preservation methods? | | | |
| **PI1:** How is an escape room designed as a teaching strategy for food preservation methods?<br>**P12:** How is an escape room implemented in the process of teaching food preservation methods?<br>**PI3:** How is the effectiveness of an escape room evaluated as a teaching strategy for food preservation methods? | | | |

## II. Methodology

### A. Subject

The experience was developed for the Food Preservation Methods course, which is part of the third semester of the Food Processing Technology Program (CPA) at the *Instituto Superior Universitario Sucre* Students who took the course during the October 2024 - February 2025 and September 2025 - January 2026 academic periods participated in the activity, with the aim of evaluating the impact of implementing an escape room.

### B. Student Types

For this activity, we had 30 students enrolled in the Conservation Methods course: 8 students from the October 2024–February 2025 academic period and 22 students from the September 2025–January 2026 period. To understand the students' personalities and playing styles, a gamification survey using the HEXAD scale [17], was administered. This tool was used to classify students according to their playing style. The survey was conducted, and the students were classified into six playing styles: socializer, free spirit, philanthropist, player, achiever, and disruptor, as shown in Table 2.

TABLE II
PLAYER TYPES ACCORDING TO THE HEXAD SCALE

| Type of Players | N° of students |
|---|---|
| Free Spirits | 10 |
| Socialisers | 5 |
| Players | 6 |
| Philanthropists | 2 |
| Achievers | 2 |
| Disruptors | 1 |
| Unknown * | 4 |
| n =total | 30 |

* Unknown indicates the number of students in the control group who did not perform the activity.

For the application of the educational Escape Room, 30 students participated, organized into four (4) working groups; the first group consisted of 8 students who took the subject in the period October 2024 - February 2025; the second group of 9 students who took the subject in the period September 2025 - January 2026, these two groups received the subject with the same teacher; the third group of 9 students who took the subject in the period September 2025 - January 2026 with another teacher; and the fourth group consisted of 4 students from the period September 2025 - January 2026 who did not participate in the activity .

The formation of the three experimental groups was based on the following criteria:

- Inclusion of at least one less common profile (disruptor, philanthropist, or achiever) in each group.
- Balance in the number of free spirits, as this is the majority profile.
- Participation of socializers and players in each experimental group to enhance communication, decision- making, and active participation during the Escape Room.
- This organizational strategy allowed for the formation of balanced teams, fostering collaborative work, equitable participation, and a meaningful learning experience for both current and former students.

The groups were organized as detailed in Table 3.

TABLE III
DISTRIBUTION OF PLAYER TYPES IN EXPERIMENTAL GROUPS

| Type of Players | Group 1 | Group 2 | Group 3 | Group 4 |
|---|---|---|---|---|
| Free Spirits | 3 | 3 | 4 | |
| Socialisers | 1 | 3 | 1 | |
| Players | 4 | 1 | 1 | |
| Philanthropists | | 1 | 1 | |
| Achievers | | 1 | 1 | |
| Disruptors | | | 1 | |
| Unknown * | | | | 4 |
| TOTAL | n=8 | n=9 | n=9 | n=4 |

* Unknown indicates the number of students in the control group who did not perform the activity.

### C. *Time and Difficulty*

The activity was designed to be completed within 60 minutes. The timer started after a brief explanation was given to the students, who were then guided through a video available on YouTube (https://www.youtube.com/watch?v=k1YVvCqgIUE). An online timer, a resource provided on the eduescaperoom.com website (https://eduescaperoom.com/contador-online-escape-room-educativa/) [18], was used to keep track of the time.

The activity's difficulty increased as the challenges progressed.

### D. *Design of the escape room*

For the design phase, the learning objectives of this activity were directly aligned with the five learning outcomes established in the course curriculum. Accordingly, the puzzles and assessment tasks were structured around these five outcomes:

1. Explain the effect of temperature and chemical additives on food quality, as well as on consumer health.
2. Identify, interpret, and apply different food preservation methods.
3. Define and draft the specifications for packaging of the product being designed.
4. Determine the importance of packaging as a sales factor in the food industry.
5. Recognize and apply regulations to the design of packaging.

### E. *Implementation of the educational escape room*

The activity took place in the laboratory at the northern campus of the *Instituto Superior Universitario Sucre*. The setup consisted of five islands and a central table from which the video and digital timer were projected (Fig. 1). Four physical padlocks with three- and four-digit combinations and a door lock were used. Additionally, once the escape room was set up, a test run was conducted to verify the accuracy of the codes and the sequence of all the puzzles.

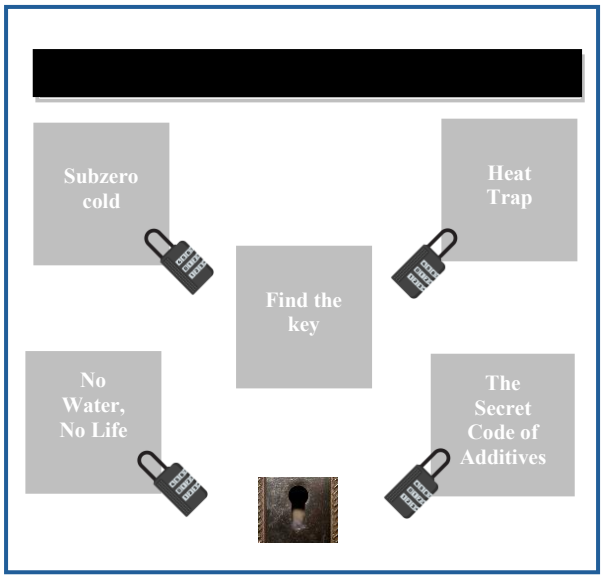


Fig. 1 Laboratory layout for the development of the escape room

The theme chosen for this escape room was "Escape from the Laboratory," for which a newspaper article and a map were created and incorporated into the environment. The newspaper article indicated that the group of students was inside the laboratory, with a risk of explosion (Fig. 2A). The map in Fig. 2B showed the route to follow to create a product. The route indicated the starting point: the first activity was "Below Zero," followed by "The Heat Trap," "No Water, No Life," and finally, "The Secret Code of Additives," (Fig. 1) which would allow them to escape the laboratory. After the introductory video, the students had to find these two tools to determine which puzzle to begin with.

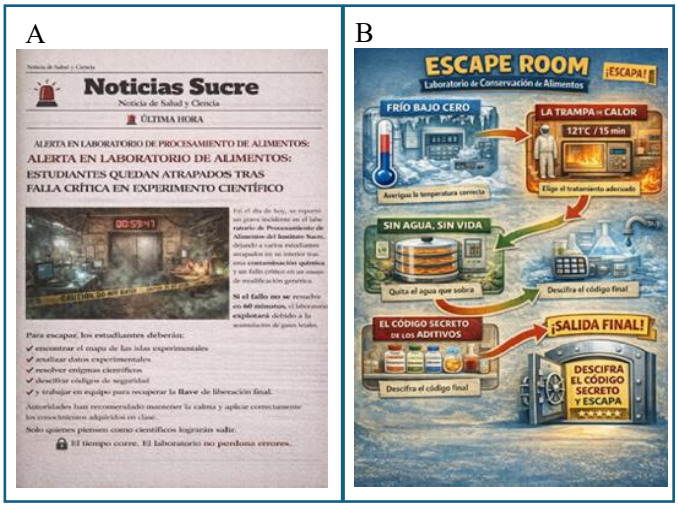


Fig. 2. A. News with the start of the escape room, B. Map to follow.

### F. Puzzles

The game consisted of five puzzles, each associated with one of the five learning outcomes for the subject. The puzzles were organized linearly and sequentially, so that when students solved a puzzle, they placed the code in a lock, which opened chests containing materials to solve it and proceed to the next station. To facilitate solving each puzzle on each island, a series of clues were provided.

When a puzzle was solved, students obtained a code that allowed them to open a digit lock. If they did not find the correct solution, they could continue trying as many times as necessary. If the code was correct, the lock opened, allowing them to advance to the next station.

Table IV details each puzzle, the description of the tool used, and the subject outcome with which it was associated.

TABLE IV
RIDDLES AND TOOLS USED IN RIDDLES

| Enigma | Tool Description | Learning Outcome |
|---|---|---|
| 1 Subzero cold | Four food cards are displayed, and you must indicate the correct storage temperature for each. Enter the code behind each temperature into the 4-digit lock. | 1 |
| 2 Heat Trap | Three food cards are displayed, and you must indicate the conditions to which each food has been subjected, in the following order: storage method, temperature, and time. Enter the code behind each time into the 3-digit lock. | 2 |
| 3 No Water, No Life | A crossword puzzle related to the four phases of dehydrating a food is presented. Once the crossword is solved, replace each letter of the alphabet with a number. Enter the code into the 4-digit lock. | 3 |
| 4 The Secret Code of Additives | Four food items are presented, indicating their ingredients and the function of an additive. The objective is to match the correct additive with its function. Once the additive is identified, add up the four values. Enter the code into the 4-digit lock, which opens the final box. | 4 |
| 5 Find the key | A box is presented with different containers with keys inside. You must choose the container with the correct label, as the key that opens the door is inside. | 5 |

### G. Escape room evaluation

The design and implementation of the escape room was not intended as a summative assessment for the course, but rather to evaluate its positive formative impact on student grades. The final course grade was used to assess the experience and determine whether it had a positive effect. Additionally, a validated survey based on the GAMEX (Gameful Experience Scale) [12,19,20], was administered. This scale evaluates the playful experience generated by gamified activities in non-game contexts. It measures user experience across six dimensions: enjoyment, immersion, creative thinking, activation, absence of negative feelings, and perceived mastery or control (Table V).

### H. Statistical Analysis

To compare scores between the different study groups, an Analysis of Variance (ANOVA) was applied after verifying the assumptions of normality and homogeneity of variances. Statistical analyses were performed using Jamovi software (version 2.6, Jamovi Project).

The data obtained from the questionnaire GAMEX were analyzed using descriptive statistics, including mean ($\bar{x}$), standard deviations (SD), and maximum and minimum values, in order to describe the scores obtained in each of the six dimensions (Table VI).

## III. RESULTS

The study was quasi-experimental, quantitative design with a small non-equivalent control group. The escape room was administered to 30 students from two cohorts: students who took the course during the academic period of October 2024 - February 2025, and students who were completing the course in the cohort of September 2025 - January 2026. The allotted time for the escape room was sufficient to solve all the puzzles; one group managed to complete the activity and open the final lock in 56 minutes.

To evaluate the effectiveness of the escape room, the final course grades were considered. The results obtained by the different groups are shown (Fig. 3).

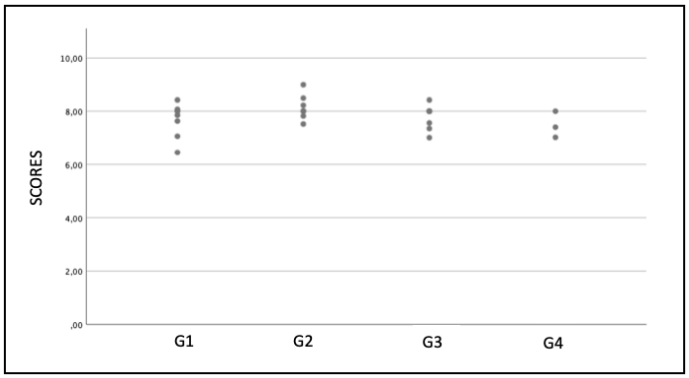


Fig 3. Distribution of scores by group

The different groups were compared using the scores obtained in the Food Preservation Methods course as the variable. Since the data showed a normal distribution, an analysis of variance (ANOVA) was applied, yielding a *p-value of 0.203*. This result indicates that there are no statistically significant differences between the groups in terms of the grade obtained. However, it was observed that group 2 had better grades compared to group 1 and group 3, respectively. This suggests that other uncontrolled factors may be influencing the results or that the sample size was insufficient to detect significant effects, which raises the need

for further studies with a more robust design and a larger sample.

Table V presents the results obtained for each of the 27 questions in the GAMEX survey. It can be observed that the questions with the lowest scores were those related to the dimensions of absence of negative feelings and perceived dominance or control.

TABLE V
RESULTS AND CLASSIFICATION OF THE GAMEX SURVEY QUESTIONS

| QUESTION | DIMENSION | Mean | Stand Dev |
|---|---|---|---|
| 1. Playing the game was fun. | ENJOYMENT | 4,4 | 1,0 |
| 2. I liked playing the game. | | 4,4 | 0,9 |
| 3. I really enjoyed playing the game. | | 4,3 | 1,0 |
| 4. My gaming experience was enjoyable. | | 4,3 | 1,0 |
| 5. I found playing the game very entertaining. | | 4,3 | 0,9 |
| 6. I would play this game for my own pleasure, not just when I was asked to. | | 4,0 | 1,3 |
| 7. While playing, I lost track of time. | ABSORPTION | 4,1 | 1,1 |
| 8. I was completely focused while playing. | | 4,2 | 0,9 |
| 9. I felt totally immersed in the game. | | 4,3 | 0,8 |
| 10. I forgot about what was happening around me while playing. | | 4,2 | 1,1 |
| 11. The game stimulated my creativity. | CREATIVE THINKING | 4,5 | 0,8 |
| 12. The game made me think differently. | | 4,4 | 0,7 |
| 13. The game motivated me to find new or alternative solutions. | | 4,6 | 0,8 |
| 14. The game fostered my imagination. | | 4,6 | 0,6 |
| 15. The game made me feel active. | ACTIVATION | 4,3 | 1,0 |
| 16. I felt energized while playing. | | 4,2 | 1,0 |
| 17. The game kept me alert. | | 4,3 | 1,0 |
| 18. The game sparked my interest and attention. | | 4,3 | 1,0 |
| 19. I didn't feel frustrated during the game. | ABSENCE OF NEGATIVE EFFECTS | 3,6 | 1,3 |
| 20. I didn't feel annoyed while playing. | | 3,4 | 1,4 |
| 21. I didn't feel anxious during the game. | | 3,4 | 1,4 |
| 22. I didn't feel stressed while playing. | | 3,2 | 1,4 |
| 23. I felt in control of the game. | DOMINANCE | 3,6 | 1,2 |
| 24. I felt I mastered the game's dynamics. | | 3,8 | 1,1 |
| 25. I felt competent while playing. | | 3,9 | 1,0 |
| 26. I felt I could influence the game's development. | | 3,8 | 1,1 |
| 27. I felt my decisions affected the game's outcome. | | 4,0 | 0,8 |

Table VI presents the results obtained from the GAMEX survey for each of the evaluated dimensions. The survey was completed by the 28 students who participated in the activity. The average total score was 4.08/5, indicating a high overall rating of the experience. The dimensions of enjoyment, activation, and creative thinking registered scores with averages between 4.3 and 4.5, considered very high. Meanwhile, the dimensions of immersion, absence of negative feelings, and absorption showed averages between 3.4 and 4.2, corresponding to a high rating.

TABLE VI
DESCRIPTIVE STATISTICS OF RESULTS OBTAINED IN SIX DIMENSIONS OF THE GAME SURVEY

| DIMENSIONS | N | Min | Max | Mean | Standard Deviation |
|---|---|---|---|---|---|
| 1. ENJOYMENT | 28 | 1,8 | 5,0 | 4,3 | 1,0 |
| 2. ABSORPTION | 28 | 1,7 | 5,0 | 4,2 | 0,9 |
| 3. CREATIVE THINKING | 28 | 3,0 | 5,0 | 4,5 | 0,6 |
| 4. ACTIVATION | 28 | 1,0 | 5,0 | 4,3 | 0,9 |
| 5. ABSENCE OF NEGATIVE EFFECTS | 28 | 1,0 | 5,0 | 3,4 | 1,2 |
| 6. DOMINANCE | 28 | 1,8 | 5,0 | 3,8 | 0,9 |
| TOTAL SCORE | 4,08 | | | | |

## IV. DISCUSSION

Escape rooms are a form of gamification that combines narrative, time pressure, collaborative problem-solving, and immediate feedback in an immersive learning environment [4]. This study aimed to design, implement, and evaluate an educational escape room for students enrolled in the Preservation Methods course, part of the Food Processing Technology program at the *Instituto Superior Universitario Sucre*.

The design and implementation of the educational escape room did not present major difficulties. The development of the activity was guided by the course learning outcomes, which served as a structured framework for the creation of the challenges. This alignment ensured that each puzzle directly contributed to the achievement of specific educational objectives, facilitating coherence between the pedagogical design and the intended learning goals.

Prior to group formation, the HEXAD scale was administered to identify participants' player types. This information was used to create balanced groups, ensuring a diverse distribution of motivational profiles within each team. Such an approach is consistent with previous studies, which highlight the importance of considering player typologies to enhance engagement and collaboration in gamified learning environments [13]. The gamified experience primarily promoted collaboration, motivation, and problem-solving among students [21]. By integrating HEXAD-based grouping, the intervention aimed to optimize group dynamics and maximize the effectiveness of the gamified experience.

One of the greatest challenges in implementing an escape room is evaluating the cognitive and/or emotional benefits the activity provides. In this study, cognitive benefits were assessed using the final grade obtained in the Conservation Methods course. No significant differences were found between the different study groups; however, a tendency for Group 2 to achieve higher grades was observed, which could suggest a potential positive effect of the intervention. Nevertheless, due to the small number of participants in each group, these findings should be interpreted with caution and do not allow for definitive conclusions. This limitation highlights the need for future studies with larger sample sizes to better evaluate the impact of educational escape rooms on academic performance. This is consistent with the findings reported in reference [22], which indicates that despite not achieving quantitative improvements in grades, the activity did facilitate the understanding and application of complex theoretical content and promoted meaningful learning, motivation, and collaborative work.

Furthermore, the development of skills such as teamwork and critical thinking is based on students' self-perception, which is insufficient to confirm real improvements in measurable academic performance [23].

On the other hand, reference [24], agrees with the above, as it points out that the implementation of active methodologies in food science education does not always generate statistically significant differences in academic performance, even though positive trends in student performance are observed. However, various sources mention that experiences such as escape rooms can improve academic performance, increase course pass rates, and strengthen performance in subsequent assessments [9,10,11]. Furthermore, reference [25], highlights that factors such as sample size and uncontrolled variables can limit the detection of significant effects, reinforcing the need for further research with more robust methodological designs and larger samples to comprehensively assess the impact of these methodologies.

To assess the emotional benefits and determine if the activity was a playful experience, we applied the validated GAMEX survey [12,19], a survey that can be applied to different types of gamified activities [12,19,20,26]. The results showed high scores in all dimensions, including the dimension of absence of negative feelings. Having high scores in the enjoyment dimension is important because it is the dimension that primarily explains the playful experience [12]. On the other hand, the dimension of absence of negative feelings, according to the survey's authors, should have low scores, and they consider it a separate dimension from the playful experience [12].

The results obtained in this study should be interpreted in light of the limited availability of directly comparable previous research. In reference [20], the GAMEX scale was validated and applied in a gamified learning experience with nursing students. When compared with the findings of the present study, similar values were observed in the dimensions of enjoyment and perceived mastery or control. Higher scores were also identified for immersion, creative thinking, and activation.

However, the “absence of negative affect” dimension showed the lowest score among all GAMEX dimensions (3.4/5). Despite this, the value still reflects relatively low levels of negative emotions during the activity, indicating that participants generally experienced the escape room in a positive manner, with only minor levels of frustration or stress. This finding is consistent with the recommendations of the original GAMEX authors, who suggest that lower scores in this dimension are expected, as they reflect the presence of some level of challenge inherent to game-based experiences [12,20].

Furthermore, most studies on escape room implementation tend to focus on general perceptions such as satisfaction or motivation, without systematically examining the gameful experience from a multidimensional perspective. In this regard, the use of the GAMEX scale represents a valuable approach for capturing a more comprehensive understanding of participants’ experiences.

Although the GAMEX scale allows for the evaluation of subjective dimensions such as motivation or enjoyment, its relationship with academic performance is limited. Improvements in psychosocial indicators with gamification have been reported, but without clear evidence of impact on traditional academic results, suggesting a possible overvaluation of the experience compared to actual learning [15].

In this regard, the present work makes a significant contribution by providing evidence of the students' experience in the escape room, evaluated using the validated GAMEX tool. This allows us to indicate that it was a playful experience in which the students enjoyed themselves, lost track of time, engaged in creative thinking, and experienced a positive state of activation. Furthermore, this study contributes to expanding knowledge about the potential of escape room games as an educational technology, providing useful information for the design, implementation, and evaluation of future gamification-based teaching and learning strategies in food science and technology programs.

Finally, the results obtained can serve as a reference for future research, encouraging comparison between different educational contexts, disciplines and implementation modalities, and reinforcing the need to continue exploring the impact of this type of active methodologies in higher education.

### *A. Limitations*

This study has several limitations that should be acknowledged. The primary limitation is the small sample size, with intervention groups consisting of 8–9 students and a control group of only four participants. This reduced sample limits the statistical power of the analyses and restricts the generalizability of the findings. In particular, the very small control group hinders robust comparisons between groups and

prevents drawing definitive conclusions regarding the effectiveness of the intervention.

In this sense, the absence of statistically significant differences in the ratings coincides with what was reported in the reference [27], who highlight that small samples and the lack of control groups limit the generalizability of the findings and the comparison with traditional methodologies.

Additionally, assessing the cognitive impact of the escape room presented methodological challenges. Academic performance, measured through final course grades, may not fully capture the specific learning gains associated with the intervention, as it can be influenced by multiple external factors. Therefore, future research should consider incorporating more specific and sensitive assessment tools to better evaluate cognitive outcomes in gamified learning environments.

## V. CONCLUSIONS

An escape room experience was successfully designed and implemented for the subject of Conservation Methods. The experience required a significant time investment from the participating teachers.

The escape room activity was successfully implemented and positively evaluated by the students; however, no significant differences in grades were observed between the study groups. Even so, the results highlight the potential of this methodology as an innovative tool for improving the educational experience.

The validated GAMEX instrument confirmed that the escape room generated a genuinely gameful experience, with high scores in enjoyment (4.3/5), creative thinking (4.5/5), and activation (4.3/5), and an overall score of 4.08/5. These findings suggest that educational escape rooms are a valuable pedagogical strategy to promote student motivation, collaborative learning, and engagement, even when short-term academic performance outcomes are not statistically significant. Future research should involve larger sample sizes, longer follow-up periods, and more specific cognitive assessment tools to fully capture the learning impact of gamified interventions in higher education food science programs.

**Credit authorship contribution statement**

Paulina Torres Castro: Methodology, Formal analysis, Data curation, Writing – original draft, Writing – review & editing. Natalia Calderón Chango: Investigation, Methodology (escape room design and implementation), Data curation, Writing – original draft, Writing – review & editing.

**Declaration of Competing Interest**

The authors declare that they have no competing financial interests or personal relationships that could have or appear to have any influence on the work reported in this paper.

**Use of artificial intelligence tools**

Artificial intelligence (AI) tools (ChatGPT, OpenAI) were used to generate visual materials for the escape room activity and to assist with language editing and manuscript clarity. These tools were not used for data analysis or scientific interpretation. All outputs were carefully reviewed, revised, and approved by the authors, who assume full responsibility for the content of this manuscript.

**Acknowledgments**

The authors would like to thank the students of the Food Preservation Methods course at *Instituto Superior Universitario Sucre* for their participation in this study. We also express our sincere gratitude to those who contributed to the logistical organization and implementation of the escape room activity.

## REFERENCES

[1] M. Grande-de-Prado, S. García-Martín, R. Baelo, and V. Abella-García, "Edu-Escape Rooms," Encyclopedia, vol. 1, no. 1, pp. 12-19doi: 10.3390/encyclopedia1010004.

[2] P. Carbajal Destre, J. R. Rodríguez Barboza, J. Palacios Garay, G. A. Ávila Sánchez, and V. Cadenillas Albornoz, "Gamificación como técnica de motivación en el nivel superior," *Horizontes Revista de Investigación en Ciencias de la Educación,* vol. 6, no. 23, pp. 484-496, 05/28 2022, doi: 10.33996/revistahorizontes.v6i23.351.

[3] J. Moreno and A. F. V. Pineda, "Competitive programming and gamification as strategy to engage students in computer science courses," 2018.

[4] I. Mateos-Aparicio et al., "Students perceive the gamification through activities based on escape rooms very positively for learning at University," IJAEDU- International E-Journal of Advances in Education, pp. 281-286, 12/31 2020, doi: 10.18768/ijaedu.819338.

[5] J. Piñero, "Análisis sistemático del uso de salas de escape educativas: estado del arte y perspectivas de futuro," *Espacios,* vol. 40, p. 9, 12/28 2019.

[6] A. Segura-Robles and M. E. Parra González, "How to implement active methodologies in Physical Education: Escape Room," in Cómo implementar metodologías activas en Educación física: Escape Room, ed, 2019.

[7] A. Marczewski, Even Ninja Monkeys Like to Play : gamification, game thinking and motivational design, Unicorn edition ed. S. l: Independently published], 2018.

[8] P. Fotaris and T. Mastoras, Escape Rooms for Learning: A Systematic Review. 2019.

[9] A. Shearer and K. Kniel, "Foodborne Illness Outbreak Investigation for One Health Postsecondary Education," Journal of Microbiology & Biology

Education, vol. 22, 08/31 2021, doi: 10.1128/jmbe.00129-21.

[10] N. Casado, J. Gañán, G. Martínez-García, S. Morante-Zarcero, D. Pérez-Quintanilla, and I. Sierra, "TANQALI “Come, acierta, escapa”.: escape room educativo coordinado entre asignaturas del grado en ciencia y tecnología de los alimentos," 2022, pp. 241-254.

[11] C. Kim, H. Na, N. Zhang, and C. Bai, "Escape Rooms for Education: A Meta-analysis," International Journal of Instruction, vol. 17, pp. 219-234, 10/01 2024, doi: 10.29333/iji.2024.17413a.

[12] R. Eppmann, M. Bekk, and K. Klein, "Gameful Experience in Gamification: Construction and Validation of a Gameful Experience Scale [GAMEX]," Journal of Interactive Marketing, vol. 43, pp. 98-115, 2018/08/01/ 2018, doi: https://doi.org/10.1016/j.intmar.2018.03.002.

[13] M. J. Rodríguez Lagunas et al., "Com desenvolupar un escaperoom educatiu per a l’aprenentatge d’immunologia: BreakOut Educatiu," Revista del Congrés Internacional de Docència Universitària i Innovació (CIDUI), vol. 0, no. 5, 09/29 2021.

[14] P. Torres et al., “Elaboración y aplicación de un escape room educativo para el aprendizaje de Biología,” *SUCRE REVIEW, Investigación tecnológica en la educación superior 2*, vol. 3, no. 1, pp. 40-50.

[15] J. López-Belmonte, A. Segura-Robles, A. Fuentes-Cabrera, and M. E. Parra-González, "Evaluating Activation and Absence of Negative Effect: Gamification and Escape Rooms for Learning," International Journal of Environmental Research and Public Health, vol. 17, no. 7, p. 2224, 2020.

[16] M. Arrue, N. Suárez, M. Ugartemendia-Yerobi, and I. Babarro, "Let's play and learn: Educational escape room to improve mental health knowledge in undergraduate nursing students," Nurse Education Today, vol. 144, p. 106453, 2025/01/01/ 2025, doi: https://doi.org/10.1016/j.nedt.2024.106453.

[17] G. Tondello, R. Wehbe, L. Diamond, M. Busch, A. Marczewski, and L. Nacke, The Gamification User Types Hexad Scale. 2016.

[18] EduEscapeRoom.com, «EduEscapeRoom», EduEscapeRoom. https://eduescaperoom.com/

[19] M. E. Parra-González and A. Segura-Robles, "Traducción y validación de la escala de evaluación de experiencias gamificadas (GAMEX)," Bordón. Revista de Pedagogía, vol. 71, no. 4, pp. 87-99, 12/21 2019, doi: 10.13042/Bordon.2019.70783.

[20] V. V. Márquez-Hernández, J. M. Garrido-Molina, L. Gutiérrez-Puertas, A. García-Viola, G. Aguilera-Manrique, and G. Granados-Gámez, "How to measure gamification experiences in nursing? Adaptation and validation of the Gameful Experience Scale [GAMEX]," Nurse Education Today, vol. 81, pp. 34-38, 2019/10/01/ 2019, doi: https://doi.org/10.1016/j.nedt.2019.07.005.

[21] I. Lim and A. Gepp, "Design, implementation, and student feedback on a numerical-themed escape room for a data analytics subject," Interactive Technology and Smart Education, vol. 23, no. 1, pp. 80-96, 2025, doi: 10.1108/itse-01-2025-0024.

[22] S. Schultze, J. Hochweber, T. Habermeyer, and S. Schneider, "A first validation of the gamification user types HEXAD scale for digital learning systems," Computers in Human Behavior Reports, vol. 22, p. 101011, 2026/05/01/ 2026, doi: https://doi.org/10.1016/j.chbr.2026.101011.

[23] Herranz et al., "¡Qué horror de día, nos toca auditoría! Desarrollo de un escape room en gestión de la calidad," ed, 2025.

[24] V. V. Mshayisa and M. Basitere, "Flipped laboratory classes: Student performance and perceptions in undergraduate food science and technology," Journal of Food Science Education, vol. 20, no. 4, pp. 208-220, 2021/10/01 2021, doi: https://doi.org/10.1111/1541-4329.12235.

[25] M. Kachaturoff, M. Caboral-Stevens, M. Gee, and V. M. Lan, "Effects of peer-mentoring on stress and anxiety levels of undergraduate nursing students: An integrative review," (in eng), J Prof Nurs, vol. 36, no. 4, pp. 223-228, Jul-Aug 2020, doi: 10.1016/j.profnurs.2019.12.007.

[26] A. Anguas-Gracia, A. B. Subirón-Valera, I. Antón-Solanas, B. Rodríguez-Roca, P. J. Satústegui-Dordá, and F. Urcola-Pardo, "An evaluation of undergraduate student nurses' gameful experience while playing an escape room game as part of a community health nursing course," Nurse Education Today, vol. 103, p. 104948, 2021/08/01/ 2021, doi: https://doi.org/10.1016/j.nedt.2021.104948.

[27] S. Trigo-Cano, P. G. Coa-Serrano, S. C. Macedo-Valdivia, and F. A. Chávez-Fernandez, "Impacto de la gamificación en el aprendizaje y satisfacción de estudiantes de odontología de una universidad peruana," Educación Médica, vol. 26, no. 3, p. 101018, 2025/05/01/ 2025, doi: https://doi.org/10.1016/j.edumed.2024.101018.