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A Hybrid Escape Room to Foster Motivation and Programming Education for Pre-Service Teachers

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ABSTRACT

Educational escape rooms aims to motivate students, to strengthen knowledge and evaluate learning. Pre-service teachers enrolled in "Computer Science and Digital Competency" course shows lack of motivation and difficulties to realise its usefulness in everyday practice, becoming an ideal context to apply this strategy. 157 students belonging to a European university participated in the experience as case study. The educational escape room was conducted following a hybrid model, mixing a physical organization of props with a virtual organization of the narrative, tests and achievements. The experiment was designed to answer two hypotheses, first if applying escape room as an educational strategy fosters pre-primary and primary students' motivation, since this method address complex concepts in a practical way, and second, if the application of this strategy as teaching strategy makes students perceive the learning process as a game.

KEYWORDS

Digital Competency, Escape Room, Game Based Learning, Games and Higher Education, Gamification, Motivation, Programming

1. INTRODUCTION

This paper explores the use of Educational Escape Room (EER) as a tool for motivating, training, and evaluating digital competencies in pre-service teachers. A pre-service teacher is a student enrolled in a teacher preparation program. They must complete degree requirements, including coursework and field experience, to earn a teaching license.

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In Spain, there are four educational levels for children. Two of these, primary and secondary school, are mandatory. The other two, elementary or pre-primary and baccalaureate, are optional.

Digital skills are crucial for future teachers for two reasons. First, these competencies enable teachers to create and share their teaching materials. Second, it is necessary for their students to acquire these essential digital skills.

The course "Computer Science and Digital Competency" trains future teachers in these digital skills. Despite being a mandatory subject, students often fear this course, finding it hard to see its relevance in teaching practice. A study by Hijón-Neira et al. (2017) reveals a significant lack of programming and computing skills among primary in-service teachers in the Madrid Community. Therefore, it is important to motivate future teachers to embrace these skills, as they are typically hesitant to do so.

This research suggests using the EER game to assist pre-service teachers in developing digital competence. The significance of games is evident throughout the history of civilizations and even in the animal kingdom, serving functions such as "social play" and "learning roles", among others (Clarke et al., 2016). Over centuries, various gaming techniques have been developed in the field of teaching. These techniques aim not only to make learning enjoyable for students, but also to foster thinking and teamwork skills through diverse, student-centred pedagogical strategies (Bilbao-Quintana et al., 2021).

Escape Room has gained popularity in education. It is a live-action game, grounded in a narrative that forms the basis of the game. In this game, a group of individuals aims to escape from a room by solving a series of challenges or puzzles tied to the narrative. Sometimes, they are aided by clues, all within a set time limit (Wiemker et al., 2015; Wilkinson & Little, 2021) .

This study uses an Educational Escape Room (EER) to enhance pre-service teachers' motivation to learn programming and improve their understanding through practice. The EER, designed as a hybrid tool, combines virtual tools with real space, objects, and physical tests/puzzles. It serves as a narrative guide and tracks students' progress in a virtual space.

The present study states two main hypotheses:

H1. EER, as an educational strategy, boosts the motivation of pre-primary and primary students by addressing complex concepts.
H2. Implementing EER as a teaching strategy allows students to perceive learning as a game, fostering feelings of accomplishment, challenge, guidance, competition, immersion, playfulness, and social experience.

The research questions are:

RQ1: Do students using the educational escape room outperform their counterparts in a typical practical classroom?
RQ2: Do students using the educational escape room perform better with different technologies than their counterparts in the control group?
RQ3: If students perform better in a certain group, which tools within that group show the greatest differences?
RQ4: Do students using the educational escape room have a more positive attitude towards the course than their counterparts in a typical practical classroom?

The article will present the EER experience and main results. After a detailed literature review on the application of ER in education, the "Materials and Methods" section will outline the EER configuration and the conducted research, explaining the selected indicators used to measure the results. The subsequent sections will present and analyse the results.

2. BACKGROUND

2.1. Game-Based Learning and Escape Room in Education

The integration of digital technologies in education has led to significant changes in teaching practices. Among these technologies games and game-based learning (GBL) are emerging as effective tools for promoting engagement, motivation, and cognitive development in learners across various educational settings.

Games provide immersive and interactive environments that mimic real-world scenarios. This offers learners experiential learning opportunities, problem-solving exercises, and skill acquisition (Akkaya & Akpinar, 2022; Gyaurov et al., 2022). GBL in education has the potential to foster critical thinking, collaboration, and creativity among learners. However, it also presents challenges that need to be addressed for its effective implementation within educational contexts.

Indeed, escape rooms are gaining significant relevance. Educational Escape Rooms, a form of Game-Based Learning (GBL), have become increasingly popular in educational settings. In these games, a team of players (students) is placed in a room, where they must solve a series of puzzles to open the door and escape successfully within a set time period (Manzano-León et al., 2021).

Escape rooms can create simulations adaptable to any subject in higher education. They have been documented as tools for fostering student motivation during the learning process, with various methodologies emerging for their application (Clarke et al., 2016; Nicholson, 2015). Escape rooms require team collaboration and communication, and students value them as curricular activities that enhance these skills (Manzano-León et al., 2021).

Subjects in Science, Technology, Engineering, and Math (STEM), including Computer Science, present challenging content to students. Several studies have applied gamification techniques to teach programming concepts to high school students (López-Pernas et al., 2019; Papastergiou, 2009), all receiving positive student feedback regarding motivation. Recently, the use of EER in computer-related subjects has increased, with studies reporting positive student feedback (Borrego et al., 2017; Lathwesen & Belova, 2021; López-Pernas et al., 2019).

Few studies report on the performance of virtual escape rooms, and those that do focus on computer science subjects (López-Pernas et al., 2019). Borrego et al. (2017) previously considered a hybrid escape room game, similar to the one reported in this article, which also deals with programming techniques. A hybrid EER combines physical challenges with virtual tools for their resolution. The application of EER as a motivating learning methodology is found worldwide, across diverse knowledge fields.

EER helps develop skills related to good teamwork, such as task division, awareness, communication, coordination, and more. It also fosters problem-solving and critical thinking skills (Brown et al., 2019).

2.2. Computing Education in Pre-Service Teachers (Pre-Primary and Primary Education)

There is a general tendency to teach programming skills to increasingly young children, from 4 years old (Bean et al., 2015; Caguana Anzoátegui et al., 2017; Chioccariello & Freina, 2019; Hijón-Niera et al., 2023), due to the new profile jobs which require digital and computational skills (Palan & Schober, 2021)

The term ‘computational thinking’ is frequently used to introduce this subject. However, it’s a controversial term due to its multiple interpretations and lack of precision (Velázquez-Iturbide, 2018). It also fails to encompass other aspects such as programming and coding. ‘Computing education,’ on the other hand, covers a broad range of concepts and skills associated with Computer Science. These include programming and elements related to ‘computational thinking’ such as problem-solving, abstraction, pattern recognition, and, among others (He et al., 2021; Stewart & Baek, 2023).

Pre-service teachers, who are future educators, need to be trained in computer education to master the subject. This will enable them to devise their own teaching strategies to effectively convey these concepts to children in their future classes (Mouza et al., 2017; Pewkam & Chamrat, 2021; Tarraga-Minguez et al., 2021).

It is often complex for pre-service teachers distinguish between computer education and digital competence. The latter encompasses a broader scope, including the skills mentioned earlier. As newcomers, pre-service teachers typically have limited knowledge on this subject and lack confidence in their technical abilities (Ivanchuk et al., 2021). Consequently, they may feel insecure and develop an aversion to the subject, which can even lead to stress when studying it.

3. MATERIAL AND METHODS

3.1. Focus and Design

The study was conducted during the 2018/19 academic year in the course titled "Computer Science and Digital Competence". This course is part of two bilingual English degrees for pre-service teachers: Pre-Primary and Primary Education at Rey Juan Carlos University. The study spanned six weeks in the spring semester. In Spain, pre-primary education caters to children aged 0 to 6 years, while primary education is for children aged 6 to 12 years.

The students were provided with identical programming content. This included an introduction to programming, covering topics such as programs, memory, variables, input and output instructions, as well as conditionals and loops. They used different software platforms to learn these concepts, *PrimaryCode* (a standalone Visual Execution Environment – VEE – to introduce these concepts to primary education students), *Scratch* (Chioccariello & Freina 2019), *Scratch Jr* (Flannery et al., 2013; Velázquez-Iturbide, 2021), and *Makey Makey* (Hijón-Neira et al., 2017) and the *Cubetto* robot (Chioccariello & Freina, 2019).

Programming is a crucial component of the course and often the most challenging for students to grasp. This difficulty primarily affects pre-primary profile students due to their low motivation to learn the subject. Many students believe that programming is not necessary for their future professional development, arguing that children are too young to engage with such content.

Although the course is primarily conducted in-person, it also includes an online component where theoretical resources are available, and assessment tasks are submitted. Moodle is the institutional e-learning platform used for these online activities.

3.1.1. Escape Room Experience

To enhance student acceptance, understanding, and engagement in the programming lesson, a final two-hour session was organized, divided into two parts. The first part involved students working in groups to practice all the concepts covered in the lesson using the tools studied. The second part consisted of an individual multiple-choice exam, serving as an evaluation tool, where the programming concepts reviewed in the practical part were assessed.

The first part, lasting 40 minutes, applied an Educational Escape Room (EER) to the first half of each degree class. Simultaneously, the other half of the students participated in a traditional activity with identical content, serving as a control group.

A key element in developing an EER is the use of themes and narratives (Clarke et al. 2017) that both justify the experience and motivate the students. A story was crafted, suitable for the students' profile and perceived as replicable in their future teaching. The experience, exclusive to the students participating in the EER, began with a video less than three minutes long, introducing the story and explaining the instructions. After the introductory video, a countdown was projected, indicating the remaining time to complete the experience, thereby encouraging gamification mechanics such as time limits.

Over 40 minutes, the students transformed into adventurers who had to overcome five challenges to escape from the EER. The other half of each class engaged in a practice session consisting of five activities, identical to the EER challenges, but devoid of any narrative or game elements.

3.1.2. Physical Organization

Two separate classrooms were reserved, one for the Educational Escape Room (experimental) group and one for the control group, to isolate the test as much as possible and prevent any influence between the two groups. The assignment of students to each group was done randomly via Moodle, which divided each classroom into smaller working groups of students.

Physical objects that coincided with the EER narrative were purchased to add a sense of realism. These objects were awarded as prizes upon passing each test related to programming, robotics, or tangible interface tools. As a result, there were four physical objects for each group in the experimental groups.

3.1.3. Virtual Organization

Moodle was utilized to monitor and record all session activities within the virtual space for the subject "Computer Science and Digital Competency" across both degrees. The advantage of using this virtual space is that students already have access, it simplifies the organization of students into groups, and it maintains a record of both the exam grades and all their activities.

The control group had access only to a PDF document containing the statements of the five activities and a quiz-type resource. They could answer the quiz only after completing all the proposed activities in the document.

When setting up the EER, it was necessary to provide a sense of progress and enhance the user experience. As the students advanced and passed the tests, feedback messages and new content would appear.

This entire process is summarized in fig. 1, which displays the resources and activities in the form of rectangular blocks on the Moodle homepage. This corresponds to the only visible tab that they can directly access, as the contents in other tabs were originally hidden. Another hidden tab displays a graph where the rest of the activities and resources are located. Grey arrows indicate conditional elements, and blue ones point to links leading to the hidden tab.

The second part of the session, which was an individual exam, was also conducted on Moodle. This was in another hidden tab specifically dedicated to assessment.

3.1.4. Hybrid Scape Room Model

Different from other EERs, which are designed in real environments with physical challenges (Boysen-Osborn et al., 2018; Gómez-Urquiza et al., 2019; Williams, 2018), and those where the challenges are purely virtual, allowing students to participate from any location (Borrás-Gené et al., 2022; Daza & Fernández-Sánchez, 2019; López-Pernas et al., 2019), the EER experience presented here integrates both analogic and digital execution features. This blend of EER execution styles is referred to in this study as a hybrid EER.

The EER has been digitally structured to guide the working groups throughout the activity, displaying the instructions and recording the progress. An e-Learning platform, specifically Moodle, managed the activity and provided feedback to the students.

The setup for the five challenges was identical. Clicking on the toy led to a page created in a hidden tab, where individual pages and quizzes were set up for all challenges. The content of each page (see fig. 2, left) was based on an image of the achievable object's silhouette, some instructions presented using an embedded slide, and an image to click on to proceed to the quiz. A quiz activity (see fig. 2, right) was created, in the hidden tab, for each challenge. Upon successful completion, feedback was provided to the group instructing them to ask the teacher for the object. A link to the

Figure 1. Scheme configuration of the EER session into Moodle

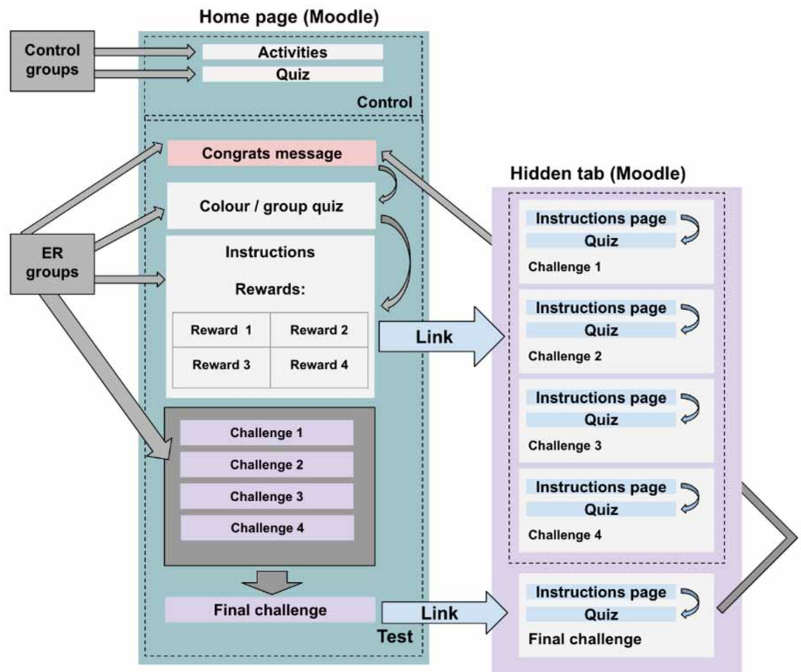
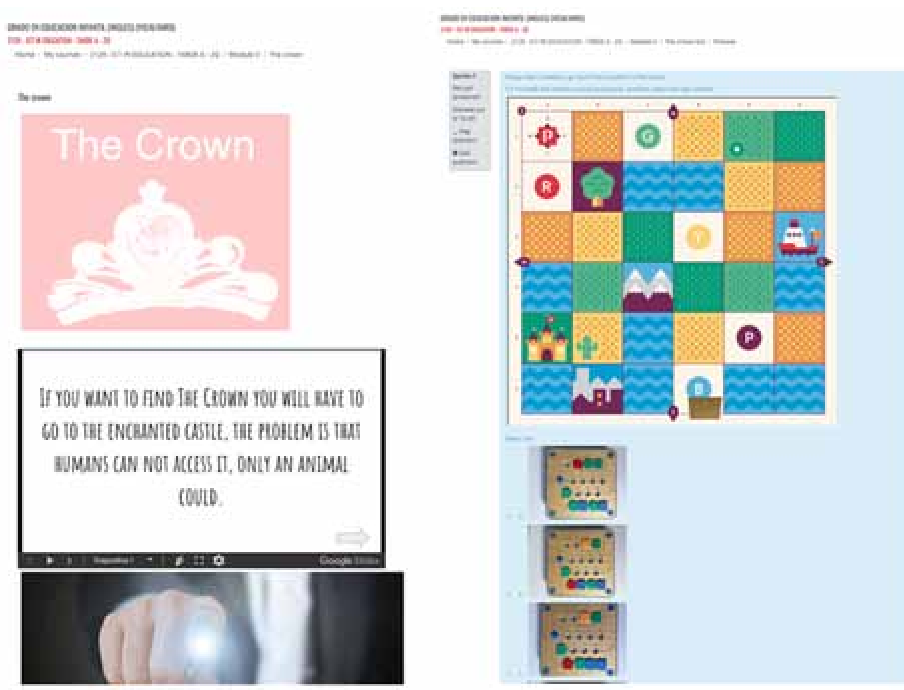


Figure 2. Example of page with instructions to recover an object (left), a quiz to get the challenge (right)



homepage was also provided, where added content would appear, including a congratulatory message and an image of the object accompanied by a number.

After the completion of four challenges, a new image appeared, linking to the final challenge that would lead to the exit. The mechanism for this fifth challenge was identical to the previous ones, utilizing the hidden tab. Upon completion of the challenge, the teacher provided a piece of paper containing the key to a code that had been requested, thereby enabling them to exit the escape room.

The analogic or physical component of the EER consisted of designated areas or zones for the working groups. It included several objects that the groups received upon completing each challenge, some of which have a tangible interface, such as the *Cubetto* robot and *Makey Makey*. Additionally, the classroom was decorated in accordance with the narrative.

4. EXPERIMENTATION

4.1. Participants

The study was conducted during a two-hour session of an undergraduate Computer Science and Digital Competency course at Rey Juan Carlos University. The course was offered to both Pre-Primary and Primary Education degree students in the spring semester of 2019. The sample consisted of 157 students: 66 Primary Education students (aged 18-49, M=19.4, SD=4.13) and 91 Pre-Primary Education students (aged 18-25, M=18.6, SD=1.24). Of the respondents, 14 were male and 143 were female.

4.2. Procedure

After the entire content and practice on programming were taught, the experimental practical session, i.e., EER, was scheduled in the last week of the course as a review and practical session. Students were given a text document outlining the purpose of the research and their right to withdraw at any time. Informed consent was obtained from every participant, along with permission to be recorded.

Students from each degree were randomly divided into two groups, control and experimental, using the Moodle random number generator. These two large groups were further divided into smaller working groups of seven students. On the day of the experience, the groups had to be adapted because some students did not attend class, resulting in working groups ranging from 5 to 9 members.

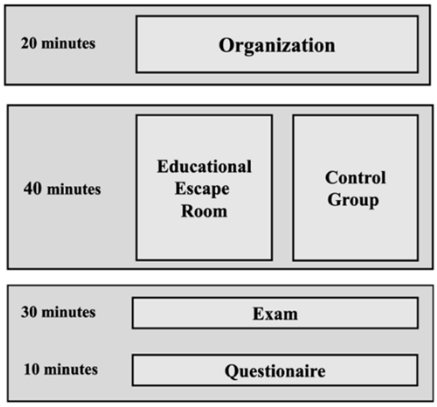
Both groups, control and experimental, performed the same set of exercises for the practical session (explained in the previous section), but the procedure was different. The experimental group completed the exercises under the educational escape room setting, while the control group performed the same exercises on the Moodle platform, without any narrative or environmental setting, just like a usual practical exercises class.

At the end of the session, an exam was administered to both groups to assess learning gained and perceptions of the experiences. Students answered this exam to explore the knowledge gained from performing the proposed activities, either in the experimental group or the control group. Additionally, students were asked to fill out an experience questionnaire to analyse their preferences and motivations towards the proposed activities. Figure 3 shows the scheme of the experience organization, where 20 minutes were devoted to distributing the students towards one setting or the other (experimental or control setting). Then they worked in parallel on the practical assignments. Finally, the exam on programming concepts and tools was administered to both groups, as well as the experience questionnaire to conclude the session.

4.3. Measurements

This study adopted a quantitative research approach. Data about the students' performance on an exam was collected in Moodle and then statistically analysed using both parametric and non-parametric techniques. Additionally, a 7-point Likert scale questionnaire was used to evaluate students' perceptions

Figure 3. Temporal organization of the experience



of their learning process and gauge their feelings of accomplishment, challenge, guidance, competition, immersion, playfulness, and social experience.

To evaluate students' cognitive engagement, their knowledge gained in either the control or experimental group was assessed by administering an exam. Each exam consisted of 12 random multiple-choice questions, one for each programming concept or tool to be mastered and used during the educational escape room. The exam, configured to last 30 minutes, deducted one-third of the total score for incorrect answers to discourage guessing. The exam grades served as indicators of learning performance.

The final exam for the subject was administered 12 days after the EER activity, and the results were also analysed. The exam's score comprised a 30 multiple-choice question survey accounting for 20% of the score, dealing with modules 1 and 2 (not related to the EER experience). The remaining 80% of the score corresponded to a practical test dealing with the contents of the EER experience in which students participated (if they were in the experimental group).

The statistical process included the use of a Shapiro-Wilk test of normality distribution to verify the data distribution. Since the data came from a normally distributed population, a t-test was used to determine whether there was a significant difference between the scores of the two groups (control and experimental). Mann–Whitney–Wilcoxon tools were applied to analyse each exam item and the final exam's items.

Students in both groups used an instrument for measuring users' gameful experience (Högberg et al., 2019). This tool was used in this case for the practical session on programming in both control and experimental groups at the end of the experience, after the exam. The validated questionnaire consisted of fifty-six questions answered on a 7-point Likert scale. The Gamefulquest had seven dimensions (accomplishment, challenge, competition, guided, immersion, playfulness, and social experience) with 7-9 items per dimension.

5. RESULTS

This section presents the results obtained from the EER experience implemented for students enrolled in the "Computer Science and Digital Competency" course across two different degree programs. The results evaluate the knowledge gained and the users' gameful experience, providing answers to the four research questions presented in this paper.

The experimental cluster was composed of six working groups, but only half of them managed to complete the EER.

Table 1. Timing of the groups that did finished the EER on time

		Time (minutes)	
	Order	Primary	Pre-primary
Finished	1º	36’	38’
	2º	39’	43’
	3º	43’	45’

As shown in Table 1, only one group was able to finish the activity within the allotted 40 minutes. However, to motivate the remaining groups to complete the activity, an additional 5 minutes was provided.

5.1. Academic Performance Results

To address Research Question 1 (RQ1): “Do students using the educational escape room outperform their counterparts in a typical practical classroom?” we conducted an analysis of the students’ performance.

After the experimental group of students completed the EER experience, and the control group conducted the activities, both groups and both degrees (Pre-primary and Primary) completed a 30-minute test. The maximum score for this test was ten.

The results are presented in Table 2. A column has been added to indicate the students in the experimental group who successfully completed the EER within the allotted time. This will provide a clearer understanding of whether the use of the educational escape room had an impact on the students’ performance compared to a typical practical classroom setting.

A slight difference was observed within the experimental group in the Primary degree, between those teams that successfully completed the activity and those that did not.

For a more detailed analysis, three groups were defined: control, experimental (those who finished the EER), and those who did not finish it. The Kruskal Wallis test was then applied, revealing that the academic results were not significantly different among the three groups, with asymptotic significance of 0.310 for pre-primary students and 0.128 for primary pupils. Subsequently, a t-test was conducted to check whether the application of an EER strategy negatively impacted the students’ performance or distracted them due to its playful nature. The test yielded p-values of 0.350 and 0.513 for pre-primary and primary students respectively. Both results are higher than 0.05, indicating no dependency between the results and the applied strategy.

In response to Research Question 2 (RQ2): “Do students using the educational escape room perform better with different technologies than their counterparts in the control group?” - a detailed analysis of the results was conducted to draw more precise conclusions. Each test question result was analysed. Each question had three states: correctly answered (positive score, +1), incorrectly answered (negative score, -0.33), or not answered. Since the data to be analysed is ordinal, the U Mann-Whitney-Wilcoxon test was conducted. The relevant statistical results are shown in Table 3.

The analysis revealed no significant improvement in the scores of the experimental groups compared to the control groups. However, in the four questions related to *Scratch*, the experimental

Table 2. Scores average and standard deviation calculated per control and experimental groups (both degrees)

	Pre-primary			Primary		
	Control	Experimental	Finished	Control	Experimental	Finished
Scores average (and SD)	3,82(2,40)	4,35(2,08)	4,38(2,25)	4,63(2,21)	4,22(2,79)	4,81(2,74)

Table 3. Analysis of students' exam scores, including control and experimental group

		PC	PC	S	S	C	SJ	PC	SJ	SJ	SJ	S	S
Pre-primary	U de Mann-Whitney	990	915	759,5	783	1010	957	972,5	951	828	1016	822	934
	W de Wilcoxon	2118	1905	1887,5	1773	2138	1947	1962,5	2079	1956	2006	1950	2062
	Z	-0,371	-1,074	-2,866	-2,188	-0,296	-0,708	-0,549	-1,343	-1,822	-0,155	-1,981	-0,88
	Sig. (bilateral)	0,71	0,283	**0,004**	**0,029**	0,768	0,479	0,583	0,179	0,068	0,877	**0,048**	0,379
Primary	U de Mann-Whitney	387	428	477	526,5	476	495	477,5	519,5	472	482,5	515	480
	W de Wilcoxon	982	1023	1072	1022,5	972	991	1072,5	1114,5	1067	978,5	1110	1075
	Z	-1,989	-1,447	-0,74	-0,008	-0,758	-0,483	-0,753	-0,141	-0,79	-0,656	-0,19	-0,688
	Sig. (bilateral)	**0,047**	0,148	0,459	0,994	0,449	0,629	0,451	0,888	0,43	0,512	0,849	0,491

PC = PrimaryCode; S = Scratch; SJ = Scratch Jr.; C = Cubetto

group (pre-primary) performed better. Similarly, the experimental group (primary) scored higher on the question related to *PrimaryCode*. These are the only significant differences identified in the exam results between the experimental and control groups. This finding addresses Research Question 3 (RQ3): "If students perform better in a certain group, which tools within that group show the greatest differences?" It was found that pre-primary students in the EER group performed better on *Scratch*, and primary students in the EER group performed better on *PrimaryCode*.

Finally, the final exam results of the subject were analysed. As the EER challenges were designed to assess content that constitutes 80% of the final exam's question bank, the results provide a comprehensive view of the students' understanding. The summary of the obtained scores for all groups and degrees is presented in Table 4.

The data presented in Table 4 reveals significant statistical findings, particularly related to the pre-primary group. As the results for both degrees did not show a normal distribution, the U Mann-Whitney-Wilcoxon test was applied to determine if Hypothesis 1 (H1) was validated. The results for the pre-primary degree group showed significance, with a p-value of 0.027 (< 0.05). Therefore, the first hypothesis is rejected as there is no dependency between the results obtained from the pedagogic method applied to the control group versus the EER method applied to the experimental group.

On the other hand, the results for the primary degree group were not significant, as indicated in Table 4, with a p-value of 0.627. Thus, the null hypothesis cannot be rejected for this group.

However, it can be inferred that the students from the pre-primary group who participated in the EER increased their motivation to study and understand the complex concepts related to the subject. They improved their score in the final exam after participating in the EER. Therefore, H1 is confirmed for the pre-primary group, i.e., the application of the EER strategy increases students' motivation as complex concepts are worked on in a practical manner.

Table 4. Final exam average scores and standard deviation, for control and experimental group and both degrees

	Pre-primary		Primary	
	Average score (SD)	% Approved	Average score (SD)	% Approved
Control	5,76 (2,4)	20,9%	7,24 (2,0)	42,4%
Experimental	**6,38** (2,5)	**29,7%**	7,05 (1,7)	42,4%

5.2. Questionnaire Results

As previously discussed, a questionnaire centred on the gameful EER experience was completed by students. The aim was not only to identify the most relevant dimensions for students but also to compare the perceptions between the test and control groups. This analysis would address Research Question 4 (RQ4): "Do students using the educational escape room have a more positive attitude towards the course than their counterparts in a typical practical classroom?".

Initially, each questionnaire item was analysed for both primary and pre-primary groups. Table 5 presents the results for both degrees, distinguishing between control and experimental groups, and the group that enrolled in the EER experience and successfully completed it (three columns per degree).

As evident from the data in Table 5, the experimental group's numbers indicate more positive perceptions than those of the control group. This gap is even larger between the students who successfully completed the EER and the control group, particularly in the Playfulness and Social Experience dimensions, and the Accomplishment dimension for the pre-primary group.

A non-parametric study was conducted using the Mann-Whitney U test (Table 6) to confirm the significance of the results and the existence of a dependency between applying the EER methodology and not doing so (H2). As shown in Table 6, all dimensions depend on the applied method for both degrees.

A similar analysis was conducted focusing on the students who passed the exam and those who did not, and those who completed the EER and those who did not. The same comparison was made within the experimental groups. No significant difference was found between the students who passed the exam and those who did not, resulting in negative statistical significance between the responses and their perceptions.

Table 5. Analysis of the seven dimensions questionnaire (Högberg et al., 2019) for EER experience

Dimensions	Pre-primary			Primary		
	Control	Exp.	Finished	Control	Exp.	Finished
Accomplishment	4,89	5,79	***6,04***	4,25	5,49	5,53
Challenge	4,61	5,50	5,42	4,31	5,32	5,31
Guided	4,47	5,54	5,48	3,99	5,14	4,96
Competition	3,66	5,57	5,85	3,79	4,99	5,02
Immersion	4,03	5,30	5,29	3,86	5,02	5,05
Playfulness	4,72	5,72	***6,00***	4,18	5,51	***5,67***
Social Experience	4,64	5,58	***5,81***	4,05	5,25	***5,40***

Table 6. U test of Mann-Whitney to measure the seven dimensions of gameful EER experience in each degree

		Accomplishment	Challenge	Guided	Competition	Immersion	Playfulness	Social Experience
Pre-primary	U de Mann-Whitney	160,5	193	235,5	218	248	204,5	250,5
	W de Wilcoxon	566,5	599	641,5	624	654	610,5	656,5
	Z	-4,265	-3,784	-3,153	-3,412	-2,965	-3,615	-2,93
	Sig. (bilateral)	**0,000**	**0,000**	**0,002**	**0,001**	**0,003**	**0,000**	**0,003**
Primary	U de Mann-Whitney	375	347,5	372,5	195,5	239	364	377
	W de Wilcoxon	1503	1475,5	1500,5	1323,5	1367	1492	1458
	Z	-4,703	-4,945	-4,727	-6,262	-5,886	-4,803	-4,597
	Sig. (bilateral)	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**

6. DISCUSSION

One of the keys to the success of games, serious games, game-based learning or gamification applied to education lies in maintaining a balance between skill level and challenge to avoid feelings of frustration or boredom (Sun et al., 2023). The activity should not be too easy or too difficult and should allow for a winner to promote positive aspects such as competition.

When introducing a new educational strategy in the classroom, it is crucial to anticipate its potential positive or negative effects on the learning process. To examine side effects, two groups were created when designing the EER strategy: a control group and an experimental group. This was done to evaluate the influences among others. Given the brief nature of the experience, no significant learning (RQ1) was measured in terms of improved results in either degree. Results were analysed for both groups and degrees, including an additional group composed of students who successfully completed the EER. The t-test showed no dependency between academic results and the applied educational strategy. There was no difference in learning level between students who participated in the EER activity and those who did not, even when comparing those who completed the performance.

An in-depth analysis of the exam items (RQ2) (Table 3) revealed significant differences between the control and experimental groups for the pre-primary education degree, i.e., *Scratch*-related questions. The best results were for the experimental group (EER group) and for the *PrimaryCode*-related question in the Primary Degree. It is interesting to note that the pre-primary group's motivation for this type of software/gadgets is quite negative. Students perceive it as difficult to learn and useless content, as their future students will not receive classes dealing with it due to their early age.

It was important to ensure that the EER strategy did not distract students from focusing on the subject's contents, thereby affecting the learning process. Although the main objective of the presented study was to motivate and improve student perception, the purpose was to review content already covered in class. The goal was to enhance motivation and improve the perception of this topic, i.e., to make students aware of the importance of teaching related content to children to develop their computational thinking and basic programming skills.

Despite the numerous studies in the literature addressing computational thinking for pre-service teachers (Bean et al., 2015; Chioccariello & Freina, 2019; Hijón-Neira et al., 2017; Hijón-Niera et al., 2023), only a few have focused on the pre-primary profile (Caguana Anzoátegui et al., 2017). Future pre-primary teachers often struggle to understand the importance of teaching computational thinking and basic programming concepts to children, which discourages them from studying this part of the subject.

The lack of motivation among pre-service pre-primary teachers is reflected in their final exam scores (Table 4), where this group scored lower than primary students. A closer look at the pre-primary exam results reveals a significant statistical difference between the experimental and control groups. Pre-primary students who participated in the EER activity achieved better results than their counterparts. This information does not indicate an improvement in the learning process, but rather a significant increase in involvement and motivation when preparing for the final exam. This motivation led to a longer study time focused on this part of the subject dealing with computational thinking and basic programming concepts, which is reflected in the results obtained by this group.

Regarding Hypothesis 1 (H1), which analyses student motivation when performing EER, it was found that this was only achieved for pre-primary degree students. They increased their motivation to study and understand the related concepts, leading to a significant improvement in their final exam scores after the EER experience, unlike the primary group.

The EER narrative was designed with young children in mind, serving as an example to future teachers of how to apply this part of the subject in their future teaching and its usefulness.

It is crucial to train future teachers to internalize computational thinking concepts and incorporate them into their future classes, following appropriate educational strategies (Mouza et al., 2017; Yadav et al., 2017). The EER activity performed provided a clear, practical example that they could replicate in the classroom with their future students.

Both the experimental and control groups (pre-primary and primary) completed a questionnaire. This questionnaire deeply analysed students' perceptions of the experience across seven dimensions. In particular, the second hypothesis (H2 - Implementing EER as a teaching strategy allows students to perceive learning as a game, fostering feelings of accomplishment, challenge, guidance, competition, immersion, playfulness, and social experience.) addresses the achievement of these feelings by the students. This will be positive for their motivation when facing this part of the subject, which is not highly appreciated since they do not understand its usefulness. When analysing the EER experience, most of the revised works measure participants' motivation in general terms, without details. Here, a detailed analysis of the interdependence between EER and motivation was carried out, measuring different dimensions thanks to the Gamefulquest questionnaire (Högberg et al., 2019).

Pre-service teachers from both degrees (pre-primary and primary) in the experimental group (RQ3) showed a positive perception of the experience across all dimensions. Meanwhile, the control group did not perceive the activity as a game, as expected, resulting in a significant statistical difference between both degrees. Focusing on the students who completed the EER and those who did not (RQ4), results show that the EER was perceived as a playful and social experience. Certain features of the EER, such as the mysterious aspect or the creative challenges, are related to the nature of games (Högberg et al., 2019).

Whether or not the student successfully completes the EER impacts the way they value the experience. Thus, we conclude that the EER design is appropriate for introducing the dynamics of the game to the students and for making them learn in an enjoyable way. It even worked with pre-primary students, who did not understand the usefulness of the subject for their future teaching activities.

The EER activity implements a hybrid version of ER, as demonstrated in previous works such as Borrego et al. (2019), where the tangible elements offer a more realistic playful experience, in line with the EER narrative. This is unlike entirely virtual experiences (Hou & Li, 2014), as it was considered that a completely virtual activity could lose the essence of ER. Students developed skills such as problem-solving and critical thinking throughout the EER activity, which are linked to "computational thinking" (Brown et al., 2019), and are beneficial for computing education in general. Thus, the EER helped in developing these skills.

When considering the basic elements shaping the EER configuration, time is one of the most relevant factors in achieving a balance between difficulty and suitability, i.e., students can eventually successfully finish the activity, but not too quickly. One of the limitations of the presented work was the estimated time. Even though half of the students in the experimental group managed to finish the EER, it was necessary to extend the time by 5 minutes during the activity, from 40 to 45 minutes. Various time periods were found in the literature when designing an ER, ranging from 20 to 120 minutes (S. Clarke et al., 2016; López-Pernas et al., 2019). When designing the proposed EER experience, the time limit (subject schedule) and the previous organization (challenges' design and estimated difficulty) should have been considered, as all working groups would have needed 60 minutes to finish the EER. Eliminating the time limit during the activity, as proposed by Daza and Fernández-Sánchez (2019), would imply missing some interesting game dynamics like time pressure (Kim, 2015).

The provision of clues during the EER activity was considered during its design since clues are fundamental elements of escape room. However, we ultimately decided not to offer clues to participants, as in other previous works (Borrego et al., 2017). A well-designed EER, including all available information to solve the challenges, will not require clues for its resolution. An important aspect when designing an EER is the number of students. The experimental group of the presented EER consisted of 8-student groups, which could be considered a somewhat large group by many authors, and some students could disconnect from the experience (Gómez-Urquiza et al., 2019; López-Pernas et al., 2019).

López-Pernas et al. (2019) advise forming groups of 4 – 5 members. Finally, the feedback design of the ER is relevant, as it is key to facilitating the teacher's control of the students' progress during the EER without external help (Manzano-León et al., 2021). During the experience, several messages helped the students to follow the activity. Moreover, this experience encourages the surprise factor, which is an aspect almost not mentioned in the literature dealing with EER. To surprise the students, the conditional tools of Moodle were used to hide the content until the exact time when the EER began. The challenges were shown just when students managed to solve the previous one, and so the narrative was growing as the students progressed in the activity, encouraging them to follow it.

7. CONCLUSION

Motivation is a crucial element in engaging individuals in a task. Through a game, several objectives can be achieved in the field of education, provided the design of the activity is appropriate. Escape rooms are gaining increasing importance in education and could become a valuable tool. Various educational methodologies could incorporate escape room activities into university teaching.

However, the introduction of a new educational strategy, such as the Escape Room Experience (EER), did not significantly improve learning outcomes. The study suggests that the EER strategy did not distract students from focusing on the subject's contents, thereby affecting the learning process.

The student motivation when performing EER, was only achieved for pre-primary degree students. They increased their motivation to study and understand the related concepts, leading to a significant improvement in their final exam scores after the EER experience, unlike the primary group. The EER activity provided a clear, practical example that they could replicate in the classroom with their future students.

Other findings include that the time factor is crucial in designing an EER. The balance between difficulty and suitability is important to ensure that students can complete the activity successfully but not too quickly. This research also found that the provision of clues, the number of students in a group, and the feedback design of the ER are all crucial factors in the success of an EER. The researchers suggests that a well-designed EER will not require clues for its resolution, and that the size of the group and the feedback design are also key factors to consider.

Students developed skills such as problem-solving and critical thinking throughout the EER activity, which are linked to "computational thinking" and are beneficial for computing education in general. Thus, the EER helped in developing these skills. Whether or not the student successfully completes the EER impacts the way they value the experience. These skills are not only useful for pre-service teachers but also for their future students, who will require this type of knowledge as 21st-century learners.

Future work includes expanding the experience to other degrees such as Computational Science at Rey Juan Carlos University, adapting the EER narrative to new student profiles, using the Moodle activity lesson instead of the activity quiz (or testing the use of clues), extending the duration of the EER to allow more students to finish (while keeping in mind that time pressure matters), and finally reducing groups to a maximum of 5 members.

CONFLICTS OF INTEREST

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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