

Future Teachers' Perceptions of Different Educational Escape Room Designs

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Abstract: Educational escape rooms have gained popularity as an innovative method for enhancing student engagement and problem-solving skills. However, little research has been conducted on how future teachers perceive different escape room designs and their potential application in school settings. This study investigates the perspectives of pre-service teachers specializing in mathematics, physics, and computer science on various educational escape room formats. The research compares four distinct escape room designs: (1) digital escape rooms created in Google Forms, (2) digital escape rooms designed using the Room Escape Maker tool, (3) fully immersive physical escape rooms designed as actual room, and (4) box-based escape rooms, which involve a physical chest containing objects and puzzles. Data were collected through multiple methods, including direct observation of students interacting with these escape room formats, interviews exploring their experiences and engagement, and an open-ended questionnaire assessing their perceptions of design effectiveness, feasibility for classroom integration, and overall educational value. The results show that while students personally preferred the immersive experience of physical escape rooms, they found digital formats to be more practical and feasible for classroom use due to lower logistical demands. However, box-based escape rooms emerged as a promising middle ground—offering hands-on engagement while being more manageable in school settings. Many students suggested combining digital and physical formats in their future teaching. The insights also inform the development of a teacher training workshop within the EcoMystery Erasmus+ project.

Keywords: Educational escape rooms, Game-Based learning, Pre-Service teacher education, Innovative teaching methods

1. Introduction

Educational escape rooms (EERs) are an innovative form of group-based game-based learning that provide dynamic, motivating environments that encourage student engagement, problem-solving, collaboration, and critical thinking (Nicholson, 2015). Derived from popular recreational escape rooms, EERs have been used in a variety of educational contexts, including STEM disciplines, where their potential to promote active learning is increasingly recognised (Taraldsen et al., 2022).

EERs are theoretically grounded in social constructivism (Vygotsky, 1978). They emphasize the construction of knowledge through real-time collaboration and interactive activities. Students engage in authentic, often complex puzzles that require teamwork and communication (Fotaris & Mastoras, 2022). This approach is also consistent with situated learning theory (Lave & Wenger, 1991), which suggests that learning is most effective in a context that reflects real-world situations and is rich in social interactions.

Several frameworks have been proposed to guide the design of educational escape rooms. One is the escapED framework (Clarke et al., 2017), which emphasises a human-centered, narrative-driven approach that supports interdisciplinary learning. This framework encourages the integration of project-based learning principles and promotes cognitive and behavioural engagement through immersive storytelling and teamwork. It places particular emphasis on the value of physical and social interaction.

Room2Educ8 (Fotaris & Mastoras, 2022) provides a design-thinking oriented framework structured around nine iterative stages: empathise, define, contextualise, design, brief, debrief, prototype, document and evaluate. This framework focuses on the ways in which EERs can foster emotional engagement, intrinsic motivation and flow state. It is particularly relevant for helping educators, including those with no previous game design experience, to create escape rooms that are pedagogically sound and adaptable to any learning environment.

Systematic reviews (e.g. Veldkamp et al., 2020) confirm that EERs can enhance motivation, knowledge retention and the development of cognitive skills when designed with careful attention to game mechanics and educational goals. Key features that contribute to the pedagogical effectiveness of EERs include narrative context, interactive problem-solving, immediate feedback and puzzle complexity. These features not only support mastery of content, but also promote ownership and autonomy in learning, particularly through collaborative engagement.

In teacher education, and particularly in the context of pre-service teachers of mathematics, physics and informatics, EERs are increasingly being explored both as teaching tools and as objects of reflection during training. Research suggests that pre-service teachers find it valuable to engage with different EER formats, such as digital story-based games and digital interactive adventure games (Čujdíková & Vankúš, 2023). In this paper we follow up with the study on how pre-service teachers perceive and evaluate four different escape room designs, contributing to a better understanding of which formats they perceive as most effective, feasible and engaging for future classroom use. Specifically, we included four different escape room formats in our study: (1) digital escape rooms created in Google Forms, (2) digital escape rooms designed using the Room Escape Maker tool, (3) fully immersive physical escape rooms, and (4) box-based escape rooms, which involve a physical box containing objects and puzzles. Therefore, our research focus is which design of the offered types of educational escape rooms do preservice mathematics teachers consider the most suitable for use in their future teaching practice.

2. Methodology

In our research, we adopted a qualitative approach (Creswell, 2012). Specifically, we chose a case study design. Our aim was to better understand how students evaluate different types of escape rooms that they had the opportunity to experience themselves. These included two types of digital escape rooms and two types of physical escape rooms, as described in more detail in chapter 3.

We posed three research questions:

RQ1: How do students perceive their experience with the selected digital escape rooms?

RQ2: How do students perceive their experience in the physical escape rooms?

RQ3: How do students perceive the usefulness of physical and digital escape rooms in the classroom?

The participants in the research were first-year bachelor's students enrolled in a mathematics education program in combination with another subject. These pre-service teachers are being prepared to teach pupils in grades 5 to 13 (ages 10–19). As part of the first year of their studies, students have the opportunity to enroll in the elective course *Game-based Teaching of Mathematics*. The aim of the course is to familiarize students with innovative learning technologies, to show them examples of their use in mathematics education and also to gain experience in creating their own learning activities in the form of digital escape games. The research was conducted within the framework of this course. A total of 14 students were involved.

We used multiple data collection methods. For digital games, students first played a sample story-based escape room. Afterwards, they worked in groups to design their own escape rooms of this type using Google Forms. Upon completion, they played the escape rooms created by other groups. The same procedure was followed for interactive adventure escape rooms created using the Room Escape Maker tool (<https://roomescapemaker.com/>).

Subsequently, in groups of 3–4 students, they played a physical escape room in the form of a real room, as well as a box-based physical escape room (Janiga, & Haverlíková, 2024).

Throughout all these activities, we observed the students and conducted interviews with them. In addition, they completed three questionnaires. One focused on their perception of the physical escape room in the form of a real room. The second gathered feedback on both digital and physical escape rooms, as well as their ideas about the potential use of these types of escape rooms in teaching. The third aimed to capture their preferences regarding the type of escape room they liked the most, and which they considered most suitable for inclusion in classroom instruction.

All collected data were analyzed through content analysis (Schreier et al., 2019), using the MaxQDA tool. In our analysis, we aimed to identify categories of ideas related to our research questions. We first coded the entire dataset using emergent codes, which we then grouped into broader categories.

3. Description of Used Escape Rooms

The aim of this chapter is to present and categorize the escape rooms used in the course. We present specific examples of escape rooms developed by pre-service teachers during this course.

The digital escape rooms in this paper can be classified into two main categories: story-based (developed in Google Forms) and interactive adventure (developed in Room Escape Maker) (Čujdíková, & Vankúš, 2024).

In the story-based category, pre-service teachers created a total of eight digital escape rooms using Google Forms, all of which integrated mathematical tasks. Two of these escape rooms focused on the theme of climate change, while the remaining six explored a variety of other thematic contexts. A specific example of a story-based escape room is “Príbeh kolobehu vody v prírode” (“The Story of the Water Cycle in Nature”; Figure 1), in which participants are tasked with saving a river and its associated reservoir tank. As they progress through the escape room, students engage with content related to the natural water cycle and its environmental significance. Simultaneously, they solve mathematical problems embedded within the narrative, such as calculating the rate of reservoir evaporation and predicting the timeline for potential drying out of the river.



Príbeh o kolobehu vody

Jedného dňa sa však rieka začala obávať, že niečo nie je v poriadku. Počas dlhého obdobia sucha sa hladina vody v nádrži veľmi znížila a oblačnosti, ktoré by mohli priniesť dážď, bolo málo. "Ako môžeme spočítať, koľko vody nám ešte ostáva?" pýtala sa rieka.



Ak jazero obsahuje približne 15000 m³ vody a každé ráno sa vyparí 3% jeho objemu, koľko vody ostane v nádrži po 10 dňoch?
Výsledok uveď v celých číslach.

Vaša odpoveď

Figure 1: Story-based escape room “The Story of the Water Cycle in Nature” (source:

https://docs.google.com/forms/d/e/1FAIpQLSeua0egf6Oq-7UMTlvoNRK1TtLWF55ZE6vfNxZNkHEU1r39_A/viewform)

As illustrated in the Figure 1, each section of the escape room presents a narrative segment (story part), an illustrative image, and a related mathematical puzzle, with a designated space for the pupil to input their answer. Depending on the needs of the story, it is possible to include multiple follow-up questions within a single segment. Once a pupil is satisfied with their response, they submit it, which leads to one of two outcomes: if the answer is correct, the system advances them to the next puzzle (i.e., the next page); if the answer is incorrect, it is highlighted in red, and a message appears indicating the response was not correct. Pupils are allowed an unlimited number of attempts to revise and resubmit their answers. However, some difficulties may occur due to formatting requirements in Google Forms. For instance, an answer may be marked incorrect simply because it does not match the expected input format. In cases where no specific format is provided in the task instructions, pupils may need to experiment with different variations until the response is accepted.

Upon successfully completing all the puzzles, pupils are informed through the concluding message that they have succeeded in saving the river, thereby achieving the story’s resolution and providing a sense of accomplishment tied to both the mathematical problem-solving and the environmental theme.

In the interactive adventure category, pre-service teachers created the same number of escape rooms as in the story-based category, using Room Escape Maker. In this case, however, their primary focus was on designing mathematically oriented puzzles embedded within a simulated virtual environment. In addition to the mathematical content, attention was given to sustaining player curiosity through interactive exploration and visual engagement.

These category of escape rooms are designed to replicate the experience of a physical escape room in an online format. At the start of the game, players find themselves in a virtual room where all visible objects are presented in front of them, and they can navigate by shifting the view to the left or right. The environment

typically includes a variety of interactive elements such as doors, furniture, and usable tools that can be collected and stored for later use (see Figure 2).

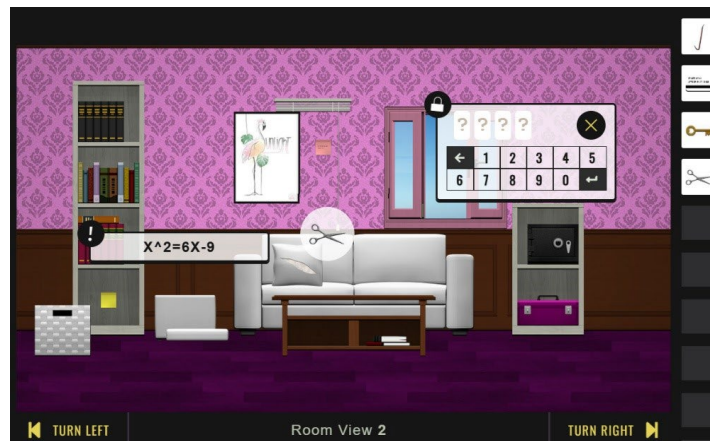


Figure 2: Digital escape room designed in Room Escape Maker (source: <https://roomescapemaker.com/u/kristi03/escape>)

In the specific example shown in Figure 2, the players have already discovered a pair of scissors, which they used to cut open a pillow. Inside the pillow, they found a card and placed it in the inventory panel located on the right-hand side of the screen. They then moved a white box, revealing a note with a mathematical clue. Although they opened a window in search of an additional hint, it yielded no useful information. Eventually, they interacted with the safe itself and discovered that a four-digit code was needed to unlock it. The inventory also shows that the players have previously explored other parts of the room. The ultimate objective is to find a specific key or a code that will allow them to unlock the exit door, which is in a different viewpoint of the virtual room.

We also provide basic information about the physical escape rooms that the pre-service mathematics teachers attended as part of their course experience. The first physical escape room designed as actual room is located at premises of Comenius University and includes two connected rooms. It is designed for teams of two to four players, requiring collaboration and communication to achieve the final goal: obtaining the “treasure”. The complex structure of the room (Nicholson, 2015) and progression of the puzzles are illustrated in Figure 3.

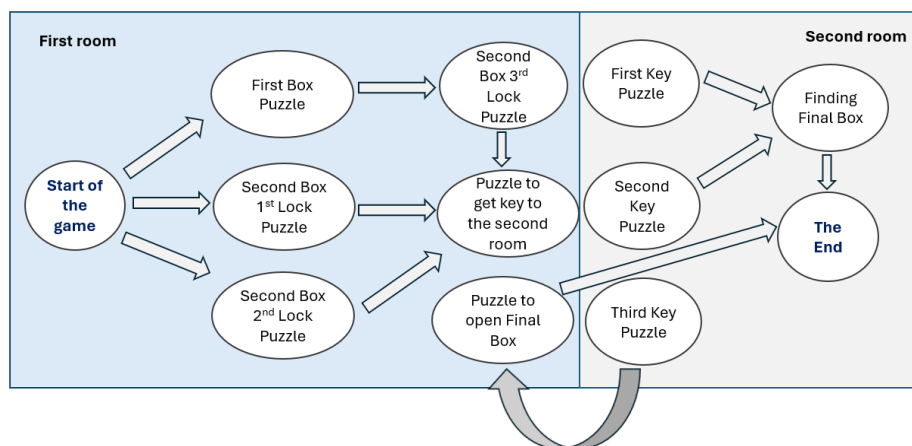


Figure 3: Structure of our physical escape room designed as actual rooms (source: authors' library)

As shown in Figure 3, participants must solve five puzzles in the first room to gain access to the second room. Once inside, they are faced with an additional set of three puzzles. Successfully completing these tasks unlocks the final puzzle, which must be solved to retrieve the key for Final Box where they can find the “treasure”, thereby marking the end of the game. In all of the puzzles, players are required not only to communicate effectively but also to apply logical reasoning and mathematical knowledge. The tasks are designed to reinforce mathematical thinking in a collaborative and engaging environment, providing pre-service teachers with a hands-on understanding of how mathematical problem-solving can be embedded in experiential learning contexts.

The second type of physical escape room that pre-service teachers encountered during the course was a box-based escape room “Chest of Lord Maxwell” (Janiga, & Haverlíková, 2024), where the primary objective was to retrieve specific information hidden inside a locked box as quickly as possible. In this particular scenario, the activity was framed by a fictional narrative: participants have a mysterious box from the late physicist James Clerk Maxwell, rumoured to contain clues leading to the discovery of a previously unknown Maxwell’s equation. The first challenge involved unlocking the main box itself (see Figure 4).



Figure 4: Physical escape room “Chest of Lord Maxwell” designed as box (source: authors’ library)

Once opened, participants found two smaller boxes inside, along with a series of clues and puzzles displayed on the inner lid. In total, the escape room included five interconnected puzzles. Each task was designed around physical principles, offering a creative and interactive opportunity to review key concepts from magnetism and electromagnetism.

4. Results

In this chapter, we present our findings. The results presented in section 4.1 address RQ1, the results in section 4.2 correspond to RQ2, and those in section 4.3 answer RQ3.

4.1 Evaluation of the Experience With Digital Escape Rooms

Although students found playing the digital escape rooms to be a less intense experience than the physical one, they still evaluated this activity positively. The main advantage of digital escape rooms, in comparison with physical ones, was seen in their independence from space, time, and group size. One student stated: *“What I liked was that we didn’t have to go anywhere, and we could all solve it at once – which is definitely more suitable for teaching. Students don’t have to go anywhere, and it’s for everyone, not just three people at a time.”* Other similar comments included: *“Can be used anywhere,” “Fast, accessible,”* or *“Convenient – you can sit on a chair.”*

Students also appreciated that, with digital escape rooms, they were not only able to play them, but also create them. In this context, they valued the opportunity to express their own creativity, and similarly to playing, they considered the digital format advantageous due to its flexibility: *“The ability to create from anywhere, at any time.”*

4.2 Evaluation of the experience With the Physical Escape Rooms

Students generally preferred the experience with the physical escape room over the digital ones. They perceived the experience of playing it as more “real.” They appreciated being physically present in the room and interacting directly with real objects. One student, for example, noted: *“That I could touch the objects and see it all live myself.”* Another commented: *“I really liked the physical escape room – it’s a different atmosphere when you’re ‘directly in the action’ and experiencing it in the room with other people.”* As this statement also suggests, another key aspect students appreciated was collaboration, and the shared nature of the game experience. Students positively highlighted the fact that some tasks had to be solved collectively: *“[What interested me was that this escape game was] also focused on cooperation between us (e.g., the snorkel).”*

Several students also liked the theme of the escape room, its design, and the individual puzzles. Most notably, they appreciated that all these elements were meaningfully connected within the room: *“I really liked the*

physical escape room we visited, it was well-designed, we had to think a lot and look for connections. I also liked that there were two rooms and the whole theme was based on the underwater world.”

The puzzles themselves were considered thoughtful and creative. Students appreciated their variety and the fact that they were not too easy, but instead presented a challenge. This is reflected in comments such as: *“I liked that it was a bit more difficult,”* or *“We had to think a lot and find connections.”* In connection with the puzzles, students also specifically highlighted: *“I liked the way perspective was involved.”*

4.3 Perceptions of the use of Digital and Physical Escape Rooms in Teaching

While students personally preferred the physical escape room, most would choose the digital version for use in the classroom. They viewed it as more suitable primarily because it is less demanding in terms of implementation, especially with larger student groups.

One student stated: *“For teaching, the digital one – it would be more efficient and take less time.”* Another expressed a similar opinion: *“The digital one, due to space and time constraints.”*

However, many students also emphasized that they would prefer the physical escape room if its implementation were easier, and that they considered the digital version more appropriate only because it is more practical. In this respect, they made comments such as: *“In an ideal world, the physical one. But it’s unrealistic for every student in a class of 30 to try it out within a reasonable timeframe,”* or *“Ideally the physical one, but digital rooms are much more practical and can be shown to more students in a shorter time.”*

Given these preferences, it may be worth considering the development and use of box-based escape rooms. This alternative was also suggested by one of the students: *“The physical one, for example, an escape game in a box – the idea of L. Janiga. Since I study mathematics and physics, I would clearly use physical ones more.”* Regarding the box escape room, some students highlighted its practicality for use with larger numbers of students and also the advantage of a physical experience compared to digital versions: *“For the pupils in the classroom I would probably like the physical box the most - by having more of them [boxes] we could solve the problems all at once and by not having it on the internet the pupils get more into it”.* Some students also advocated the use of both digital and non-digital versions: *“Digital in Google Forms or physical box. The physical box is very good for teaching science and for pupils to actually work with those things and tools and Google Forms I think is useful for teaching maths - because maths is mainly made up of tasks. Both approaches are very good and have their good points, so I think we can use them together.”*

The following Table 1 summarizes the key themes of our finding and participant feedback.

Table 1: Summary of key themes and participant feedback

Themes	Key Findings	Illustrative Quotes
Experience with digital escape rooms	Students appreciated the flexibility, accessibility, and opportunity to create their own games. They valued that the format was not limited by their location or time.	<i>“We didn’t have to go anywhere, and we could all solve it at once.”; “Can be used anywhere.”; “The ability to create from anywhere, at any time.”</i>
Experience with physical escape rooms	Students preferred physical rooms due to the immersive experience, teamwork, and hands-on interaction with real objects.	<i>“That I could touch the objects and see it all live myself.”; “It’s a different atmosphere when you’re directly in the action.”; “We had to think a lot and find connections.”</i>
Usefulness of escape rooms in teaching	Digital escape rooms were considered more practical for classroom use, especially with large groups. Box-based rooms were seen as a good compromise.	<i>“For teaching, the digital one – it would be more efficient and take less time.”; “Ideally the physical one, but digital rooms are much more practical.”; “The physical box is very good for teaching science.”</i>

5. Conclusion

In our paper, we investigated the preferences of pre-service mathematics teachers regarding the design of educational escape rooms. As part of a university course in *Game-based Teaching of Mathematics*, students engaged with different types of escape rooms. These were digital educational escape rooms in the form of story-based escape rooms created in Google Forms, and interactive adventure escape rooms designed using the Room Escape Maker tool. Students also completed two types of physical educational escape rooms, namely fully immersive physical escape rooms designed as actual rooms, and box-based escape rooms, which involve a physical chest containing objects and puzzles.

During all these activities we observed and interviewed the students. In addition, they completed several questionnaires. Students were active while working so the escape rooms exposed them to collective teamwork, foster engagement and persistence in completing tasks, strengthen social relationships, activate team spirit, and facilitate the benefits of deep learning through group discussion, which is consistent with previous researchers' experiences in this area (Fotaris, & Mastoras, 2019). The positive response to immersive and embodied activities aligns with situated learning theory (Lave & Wenger, 1991), which emphasizes that learning is most effective when it occurs in meaningful contexts that reflect real-world experiences.

As for the results we found out, that students preferred physical escape rooms themselves, but they found digital more suitable for classroom integration. Students' preference for physical escape rooms, despite recognizing the practicality of digital formats, underscores the importance of physical and social interaction in learning — a key principle of social constructivist theory (Vygotsky, 1978). The collaborative, hands-on nature of physical escape rooms appeared to support deeper engagement and mutual problem-solving, allowing knowledge construction to emerge through interaction with peers and with tangible materials in real time.

However, after the students experienced the box-based escape rooms, they realized that this form is appealing to them and at the same time it is also suitable to use in a classroom setting. Based on this, several of them concluded that they would use digital learning escape rooms in combination with box-based physical escape rooms in their future teaching practice. These results are consistent with previous studies that have noted the practicality of using box-base physical escape rooms in education (Duggins, 2019). The results will also inform the development of a teacher training workshop focused on the use and creation of box-based escape rooms with a theme of climate crisis issues. These trainings will be part of the ERASMUS+ project The EcoMystery Project: Interactive Escape Rooms for Climate Crisis Awareness and Civic Engagement in School Education, which focuses on designing educational escape rooms with themes related to climate change.

While the study provides valuable insights into pre-service teachers' perceptions of educational escape rooms, the findings should be interpreted in light of the small sample size of just 14 participants. As a qualitative case study, its primary aim was to explore experiences in depth rather than produce generalisable results. However, future research could build on these findings by conducting larger-scale studies to validate and extend the observed trends. Furthermore, longitudinal research could examine how attitudes towards educational escape rooms evolve as pre-service teachers transition into their careers and apply these tools in real classroom contexts.

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Ethics declaration: This study was conducted in accordance with the ethical guidelines for educational research. All participants were informed about the purpose of the research, their rights as participants, and the procedures involved. Participants were assured of the confidentiality of their responses. All data collected were stored securely and used solely for research purposes in accordance with applicable data protection regulations.

AI declaration: Artificial intelligence tools (specifically ChatGPT by OpenAI) were used to support the preparation of this paper. AI assistance was employed for improving language clarity and formalising style. All intellectual contributions, research design, data interpretation, and final decisions were made by the authors.

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