

The Quest for Learning: Pedagogical and Interaction Design Perspectives on Quest Rooms

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Abstract: Educational Escape rooms (EERs) foster learning engagement, but have been criticized for promoting extrinsic motivation and shallow learning by overemphasizing game elements. To address this, it is essential to better align game mechanics with desired learning outcomes and consider the relationship between EER interaction design and pedagogical theories. This work combines educational and interaction design methods to improve escape rooms as a pedagogical format. We introduce an escape room design approach here named *the quest room*, adapted for informal learning at museums. Using a Research-through-Design methodology, we present three digiphysical quest rooms developed and implemented at museums. Further, we propose an edu-interaction framework that combines five lenses of analysis: playification, embodied aspects, sociality, game mechanics, and interactive storytelling, to analyse the quest room exemplars. The study offers insights for designing and evaluating future EERs.

Keywords: Educational escape rooms, Playification, Embodied learning, Interactive storytelling, Research through design

1. Introduction

Currently, there is a lack of knowledge on how educational escape rooms (EERs) can be systematically designed to support deep and meaningful learning, especially in informal settings such as museums. While EERs are increasingly used to foster engagement, collaboration, and creativity, their design often emphasizes gameistic elements—such as time pressure and competition—that may undermine educational goals. While there is an abundance of research on EERs, gamification, and game-based learning (e.g., Clarke et al., 2017; Plass et al., 2020; Arnab et al., 2015), they do not focus on how to align EER design with educational and interaction design theories to ensure that game mechanics support rather than distract from learning. This lack of integration has been highlighted in literature reviews on EERs, for instance by Vorderobermeier et al. (2024), Veldkamp et al. (2020), and Nicholson (2018), who emphasize the need for more theoretically grounded and pedagogically aligned design approaches.

This research aims to explore a new approach to educational escape rooms that better supports learning, particularly in informal learning settings such as museums. We approach this aim by asking how educational and interaction design principles can be integrated to create quest rooms that support informal learning in museums. We approach this aim by asking how educational and interaction design principles can be integrated to create quest rooms that support informal learning in museums?

The study follows a Research through Design approach, presenting three iterations of the Quest Room, a type of EER designs adapted for museal settings. An edu-interaction design framework is presented and utilized to analyse the designs.

2. Educational Escape Rooms

Escape rooms, initially developed as a leisure activity, are widely used in formal and informal education (Veldkamp et al., 2020; Vorderobermeier et al., 2024), including museums (Karageorgiou et al., 2021). EERs enhance collaborative and creative engagement, but elements such as time pressure and competition can distract from learning aspects (Fotaris and Mastoras, 2019; Warmelink et al., 2017), making the EERs too gamistic (Veldkamp et al., 2020; Vorderobermeier et al., 2024). While frameworks for analysing EERs exist, such as the Eduscape framework (Clarke et al., 2017), they offer a practical tool for designing EERs rather than theoretical analysis.

2.1 Educational Escape Rooms at Museums

EERs are used in multiple ways in museums (Karageorgiou et al., 2021), and is increasingly popular to implement. Desired outcomes in EERs at museums include authenticity, emotions, and immersion. (Nowacki and Stasiak, 2025; Pakhalov and Rozhkova, 2020). Design approaches vary from digital (Tzima et al., 2020) or VR (Valera Jr. et al., 2024) to built-up immersive ERs (Pakhalov and Rozhkova, 2020). Such as *Escape Extinction* at the Swedish

Museum of Natural History (Naturhistoriska riksmuseet, no date) and escape room projects at the Rijksmuseum in Amsterdam. Most museum EERs require active facilitators from the museum, even though this is resource-intensive and challenging (Richardson, 2024), but they can be designed as interactive exhibitions that operate without facilitators (Back et al., 2019).

2.2 Educational Theories for Escape Rooms

Positive learning outcomes from hands-on activities, learning by doing (Dewey, 1916), experiential learning (Kolb, 2014), and active learning (Bonwell and Eison, 1991) are well known in education theory. Numerous studies show that active, collaborative, and problem-based activities improve learning outcomes (Freeman et al., 2014; Prince, 2004), and EERs are a clear example of such an activity. Dale's cone of experience categorizes activities that enhance memory and long-term learning (Dale, 1946; Jackson, 2016), and EERs can be placed high on that scale.

EERs can foster collaborative learning (Vidergor, 2021), where students work together to solve problems. This aligns with Vygotsky's theory of development which emphasizes the importance of social interactions and scaffolding in learning (Doolittle, 1997; Vygotsky, 1962).

Challenge-based learning addresses real-world problems collaboratively. One such approach is Quest-based learning (Snelson, 2022), which provides students with different quests that offer a progression based on their current skills. This ties into the proximal zone of development (Doolittle, 1997; Vygotsky, 1962).

Embodied cognition holds that thinking and learning are grounded in the body's sensorimotor systems and environmental interactions (Varela et al., 1991; Shapiro, 2011). Embodied interaction enhances learning (Glenberg, 1997; Macedonia, 2019). This perspective is relevant when designing physical or digiphysical EERs where manipulating physical artifacts and spaces supports engagement and memory. And such EERs can offer multimodal, tangible, and sensory experiences (Bakk, 2024), tying into theories on deep multimodal learning (Ramachandram and Taylor, 2017), and research showing that bodily engagement enhances learning (Macedonia, 2019; Barsalou, 2008; Glenberg, 1997).

EERs can be seen as a form of game-based learning (Plass et al., 2020) and the concept of serious games (Arnab et al., 2015). Games has many strengths, but can trigger extrinsic motivation (Andrade et al., 2016; Mekler et al., 2017) and can be related to educational theories on shallow learning (Entwistle, 1983). In EERs, this is reinforced by time pressure and the escape narrative. A literature review from 2020 suggests that EER design should focus more on creating a relation between the game mechanics and the educational goals, to be an efficient tool in teaching (Veldkamp et al., 2020).

EER can be seen as a playful activity, related to playful learning approaches (Whitton, 2018; Veldkamp et al., 2021). Play enhances the brain's plasticity (Himmler, 2011), and within neurocognitive educational research, the effects of playfulness on the brain have received increasing interest (Siviy, 2016).

EER storytelling aligns with story-based learning (Diermyer et al., 2009), with stories creating meaningful learning situations (Diermyer et al., 2009). Interactive storytelling can promote cultural heritage awareness (Alinam et al., 2021), enhancing learning through storytelling and immersion (Bormann and Greitemeyer, 2015; Lordly, 2007).

2.3 Interaction Design for Escape Rooms

Embodied interaction (Dourish, 2004) becomes relevant in relation to physical escape rooms. Physical Hybrid installations allow engagement materials for rich experiences (Bannon et al., 2005), providing tangible interaction. Real-life EERs can be designed for multimodal and embodied experiences. EERs are multiuser, collaborative, and can be designed to enhance communication and sociality (Pan et al., 2017).

Interactive storytelling in design can create engaging experiences (Greene, 1996), for instance, in cultural heritage-related EERs (Paananen et al., 2024). Non-linear formats, such as in games, differ from linear storytelling (Zagalo, 2020), breaking up the narrative through player agency (Adams, 2013; Paulsen, 2021). Transmedial (Jenkins, 2012; Paulsen, 2021) and multimodal storytelling (Alinam et al., 2021) can also be incorporated in EER design.

EERs have game and play elements. Games and play are inherently different, even oppositional (Caillois, 1961). Play is characterized by more freedom and exploration, while games are more confined by rules, focusing on contests between powers (Salen and Zimmerman, 2003; Sutton-Smith, 1966). Designing for play gives a big design palette, as rule-based play, such as games, is just one play type in Hughes' taxonomy, that also includes

role play, explorative play and object play, among others (Hughes, 2006). The concept of ludic design has been implemented within an interaction design context, relating to playfulness rather than gameism (Christina, 2021; Gaver et al., 2004). EERs can draw on playfulness through role play and storytelling, to enhance learning (Veldkamp et al., 2021).

Gamification (Deterding et al. 2011) is effective to create engagement but risks promoting shallow reward-driven behaviours (Andrade et al., 2016). To mitigate the problems with gamification, playification has been proposed as an alternative approach (Carbone et al., 2021; van Turnhout, 2012; Márquez Segura et al., 2016), leveraging on playful behaviour such as curiosity, sociality, storytelling, and exploration (Davis, 2018). Playification can be utilized in museums to enhance cultural heritage awareness and for engaging hybrid play installation design (Back et al., 2023; Márquez Segura et al., 2016).

Game mechanics are the core rules and systems that define how a game is played. Broadly, it can be seen as the behaviors within a game that a game promotes (Salen and Zimmerman, 2003). Game mechanics can be designed to promote learning (Arnab et al, 2015). Escape rooms often in a problematic way utilize game mechanics superficial to the learning concepts (Nicholson, 2018).

3. Method

This study follows a Research through Design (RtD) approach where researchers generate knowledge by designing (Zimmerman et al., 2007). This study emphasizes designing and analysing conceptually rich artifacts rather than user studies (Pierce, 2014). The analysis draws inspiration from artifact analysis (Trausan-Matu and Slotta, 2021), with a design artifact analysis through educational and interaction design concepts and theories. The study uses annotated portfolios (Gaver and Bowers, 2012) to create intermediate-level knowledge (Höök and Löwgren, 2012). Thematic analysis is utilised for the analysis. The Interaction Design approaches were mainly pre-formulated, informing the design process based on previous research. The educational theories are identified retrospectively, building on the RtD concepts of emergence (Gaver et al., 2022) and reframing (Zimmerman et al., 2022). All three quest rooms are designed by the authors in close collaboration with museum design teams over several years.

4. Shared Design Traits of the Quest Rooms

The quest rooms are adapted to the museum informal learning context. They are digiphysical installations (Fiedler and Skorin-Kapov, 2025; Pysander et al., 2020), building on a hidden technology approach, non-intrusive to the physical experience of the room.

The format differs from ordinary escape rooms in that several groups can partake in the experience asynchronously and independently of each other. No time pressure is included; a slow and thorough exploration is encouraged. Instead of escape, users unravel mysteries, with non-linear quests tied together in an overarching narrative. The quest rooms are built to be self-instructive without facilitators. The main technology enhancement is a central panel (Figure 1), with quests mapped to buttons in the central panel. The buttons have ludic markers, with corresponding markers found around the room. When solving a quest, the user returns to the central panel, pushes the ludic symbol, and the answer button or code, getting light and sound feedback.

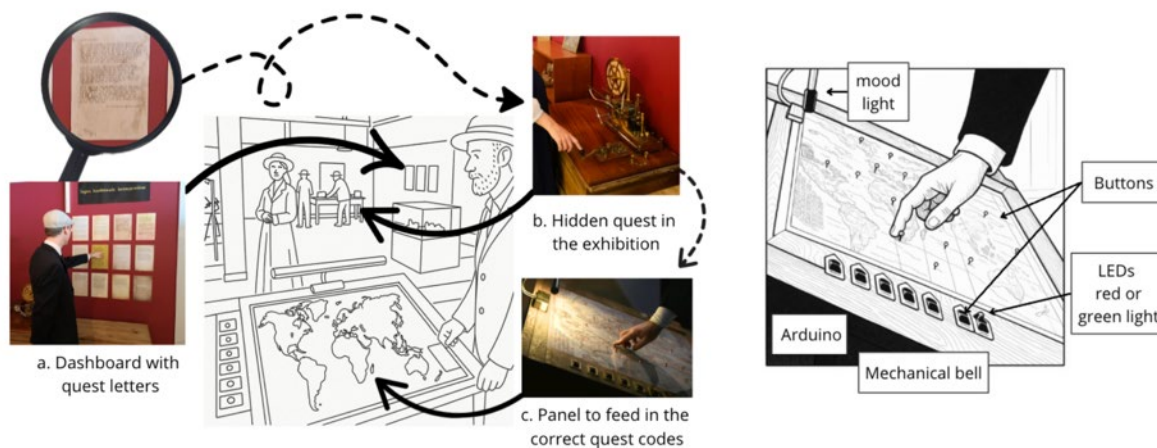


Figure 1: Annotation of quest room general design structure

Each quest contains its own game mechanics and knowledge content; they are free-standing and can be solved in any order. The quests can be modified and replaced without changing the functionality of the central panel, enabling the quest room to be remade with new designs over time.

5. Design Exemplars

5.1 Iteration 1: The Adventures of Ingrid Johansson

This design, shown in Figure 2, was developed in collaboration with the Swedish National Museum of Science and Technology and an artist group. The exhibition was presented in a non-public room, open only to invited groups.

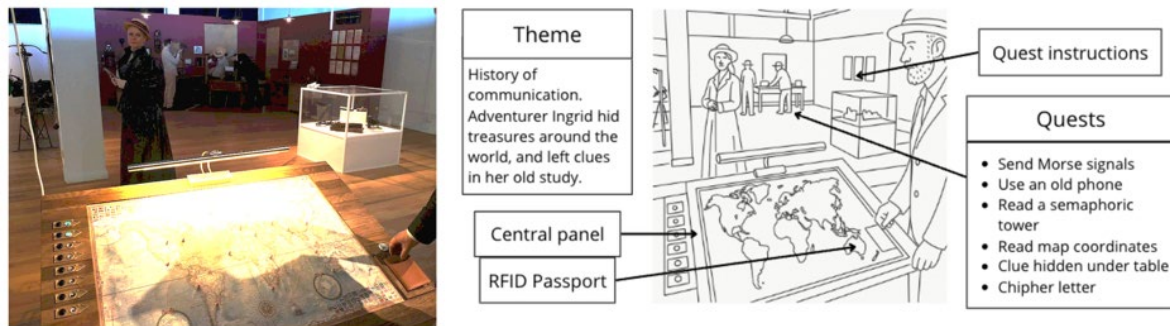


Figure 2: Overview of layout for the Adventures of Ingrid Johansson

It contained eight quests. As grandchildren of (fictitious) explorer Ingrid Johansson, players solved quest puzzles throughout the exhibition. Each visitor got a specially designed passport, containing an RFID chip. The quest was consolidated by placing the passport on a central panel, then pushing the corresponding quest symbol and the correct city on the world map. Progress was saved on the panel through the passport. Solving all quests resulted in the light blinking and the bell ringing, signalling that the quest room was completed.

The room was tested twice in 2019, with a total of around 30 invited participants. Combining observations, group interviews, and a survey, we found that most participants enjoyed the experience, especially the collaborative nature and aesthetics of the room. Most stayed for at least 30 minutes to an hour. The engagement of the participants and the desire to solve quests were strong in most groups.

The integration of puzzle solving in a sensation-rich environment that integrated museum objects, interactive exhibitions, and fictional and factual narratives created an interesting effect where users could interact in a range of ways. Problem-solving behavior emerges as the dominant form of engagement, but it did not come at the expense of more general exploration or learning dialogue.

Most participants reported gaining new knowledge, including a deeper understanding of technology and detailed information, such as how longitudes and latitudes on maps function. Participants skimmed text signs for clues, rather than deep reading. Quests involving physical actions, such as sending Morse code or using a map, seemed to spark the most learning conversations.

5.2 Iteration 2: The Quest - Subject Hello!

Based on the first iteration, this quest room is a part of a permanent museum exhibition. Due to COVID, tangible elements had to be removed, and the central panel was designed as an app. For an actual exhibition, the museum personnel did not want to include a fictional character explicitly, so while keeping the theme from iteration 1, it was toned down. The narrative centred on solving five quests to open a locked chest (Figure 3).

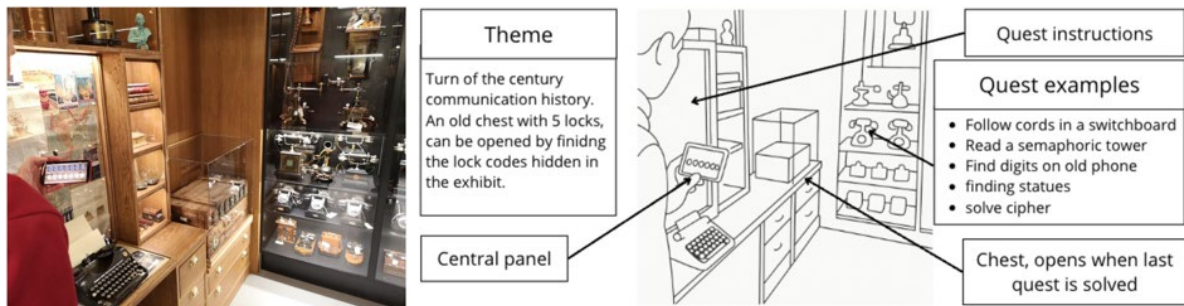


Figure 3: Interaction design overview of quest room iteration 2

The quest room was tested through in-the-wild observations after inauguration, app data, and a participant thick description of the user experience. This exhibition struggles with onboarding issues, but those who start playing show engagement, there are few app users per day (10-20), but those solving many quests. Observations showed that many did not initiate the game, but those who solved one or two quests got hooked; “I went back to the board, now determined, I want to solve the others now. I was now really engaged to the game.”. The presence of other groups seem to work as an inspiration “The others in the room also really helped. They provided a slight hint, when I overheard their discussions, or saw the spots they were looking or sitting. It also helped to see them struggling, feeling not alone in my struggle.”

5.3 Iteration 3: The Archive Quest

This quest room (Figure 4) was developed as part of the newly developed Uppsala Castle Museum. The narrative builds on Ingeborg, an authentic castle archivist who retired in 1978. Storywise, she left behind a messy desk of unsolved historical riddles connected to historical figures, and the players act as investigators. Each quest represents one method for getting knowledge of the past.

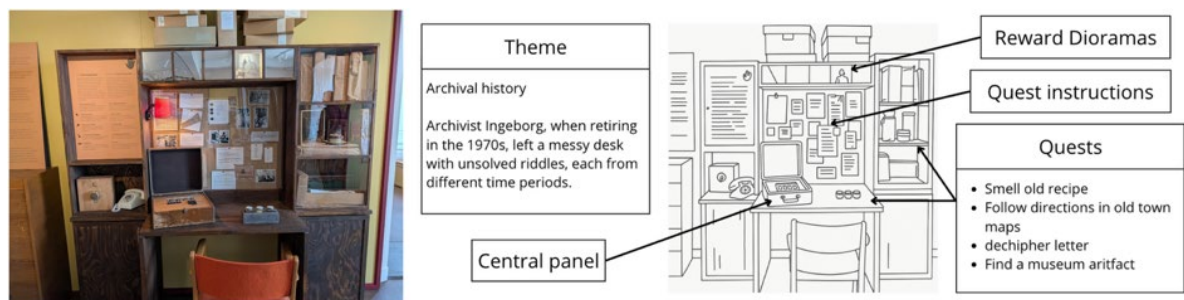


Figure 4: Overview of the layout for The Archive Quest

A master thesis project by Nandakumar (2025), on visitor engagement, included testing the quest room with invited groups. The data was analysed using self-determination theory, showcasing how it sparked curiosity, enhanced feeling of competence through well-balanced difficulty level, provided autonomy through self-directing exploration, and relatedness through collaboration. The participants stated that while the quests were not very difficult, they still sparked curiosity. Especially watching others seemed to give new perspectives and reinforce learning. Participants in the study expressed satisfaction in exploring hidden clues, cooperating to unravel mysteries, and felt intrigued by the archival narrative. (Nandakumar, 2025)

During the inauguration day in May 2025, with approximately 500 visitors, the quest room was observed using a protocol for engagement. Preliminary analysis shows engagement through problem-solving, discussions, and exploration of the room. Visitors referred to the quests, such as the one about 17th -century stomach medicine, rather than just discussing the smelling quest, indicating a connection between the activity and the learning content of the written texts. Museum personnel, a few weeks after the inauguration, describe the quest room as well-functioning, well-used, and with most visitors understanding and enjoying it.

6. Edu-Interaction Design Analysis Framework

In this section, the educational and interaction design concepts introduced in the background are combined into a joint framework, creating an edu-interaction design analysis framework for EER, and utilized on the design exemplars of the quest rooms (Figure 5).

Sociality. The quest rooms are designed as cooperative social activities that encourage collaborative learning. An interesting behaviour observed in all the quest rooms is that players tend to collaborate a lot within their group while actively ignoring what other groups do, creating collaborative learning in groups.

Embodied Aspects. Quest rooms encourage embodied interactions following principles from embodied cognition. Embedding the quest into the environment promotes movement, sensory engagement, and physical manipulation of objects, thereby integrating bodily engagement into the learning experience. Multisensory and tangible approaches include smell-based quests, turning an old telephone crank, and pushing Morse code buttons. Hidden technologies allow players to focus on tangible exploration and collaboration. Removing tangible aspects, as in the second interaction, reduced some of the potential for embodied learning.

Playification in the design exemplars includes the role-play layers, the removal of time pressure and competitive elements, and the promotion of exploratory and social play. Ludic markers and other scenography are designed to afford playfulness. The playification approach promotes intrinsic motivation, sociality, and exploration.

Interactive Storytelling. Each quest room can be seen as a form of embedded interactive storytelling. The story intercepts the whole experience ambiently through scenography, props, texts, and visuals and is integrated into the quest mechanics. Through multimodal storytelling, the users interact with and explore the story hands-on with several senses. Building more on this and having a stronger narrative focus could enhance those aspects of a quest room design.

Game mechanically driven learning. The learning experience could be strengthened if the quests' activity, or game mechanics, map to the learning goals, supporting meaningful engagement rather than superficial play. An example is how the quest of sending a Morse code across the room will make you learn Morse code in the process of solving the quest, while a generic quest, such as solving a cipher, is more detached from the intended cultural heritage learning.

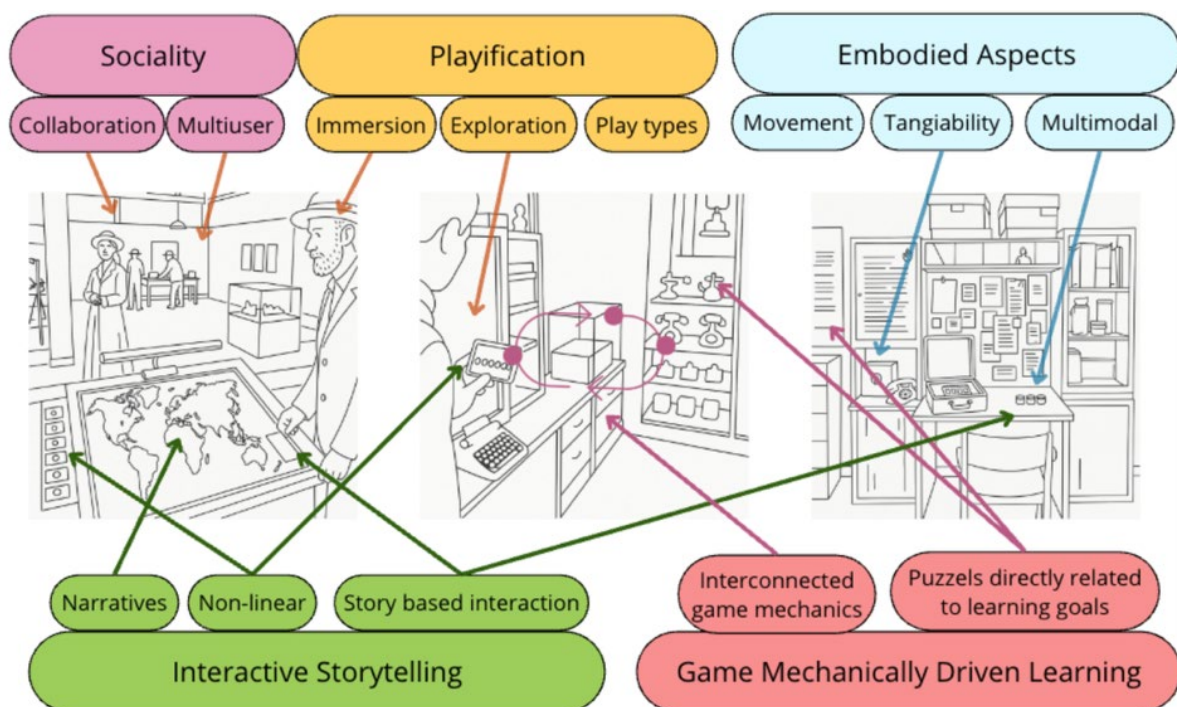


Figure 5: The edu-interaction design framework applied to the quest rooms

7. Conclusion

This study presents a design concept, the Quest Room, that adapts the EER approach to informal learning in museums. The Quest Room design approach is analysed through an edu-interaction design framework, combining educational and interaction design concepts and theories through five lenses of analysis: sociality, playification, embodied aspects, interactive storytelling and game mechanically driven learning. This study aims at opening up for combining interaction design and educational theories for designing and evaluating digiphsical educational installations such as EERs. This study can be seen as a first step. The paper presents a framework for analyzing educational escape rooms, but it is only applied to the three examples the authors

designed. To make the framework more reliable, it would help to test it in other learning contexts, such as formal education or science centers, as well as by involving other designers. Comparative studies, structured user evaluations and learning assessments could help validate and refine the framework. The quest room design can be further studied, tweaked and implemented for educational environments at museums and beyond.

Ethics declaration: As per standard procedure in its country of origin, the project was submitted to the national ethics committee, which found that it did not need ethical approval.

AI declaration: AI (ChatGPT 4.0) was used to convert photos into sketch-style outlines for figure annotations. Additionally, AI (ChatGPT 4.0 and Microsoft Copilot) was used editorially to correct grammar and language. The authors otherwise produced all content and results without AI assistance.

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