

POSSIBLE UTILIZATION OF GENERATIVE ARTIFICIAL INTELLIGENCE TOOLS FOR CREATING DIGITAL EDUCATIONAL ESCAPE ROOMS

Ivan Stojšić^{1*}

¹University of Belgrade, Faculty of Biology, Centre for Educational Technology, Didactics' Training and Career Guidance of Biology Teachers, Belgrade, Republic of Serbia,
e-mail: ivan.stojasic@bio.bg.ac.rs



Abstract: Escape rooms used for teaching purposes are usually called educational escape rooms. Educational escape rooms are cooperative games designed for teaching particular educational material based on a series of narrative-driven puzzles that group(s) of pupils/students must solve within a limited time to achieve the goal of the game and leave a room or environment (or alternatively break into the locked box or unravel a mystery). The shift to online teaching caused by the COVID-19 pandemic increased the use of educational escape rooms in a digital format. Digital educational escape rooms are escape game-like interactive activities (based on educational content) that are made with digital technologies. Most of the research studies and literature reviews suggest that digital educational escape rooms could have some positive impacts on students' cognitive, behavioral, and affective learning outcomes. However, a significant amount of digital escape games created by teachers lack engaging story, challenging narrative-based puzzles (that are related to specific learning objectives), and cohesive graphics. Therefore, the practical usability and effectiveness of such games in real and virtual learning environments are questionable. In the field of educational game development, generative artificial intelligence can play a significant role in simplifying the process, improving quality, and saving time. This paper discusses how teachers could utilize generative artificial intelligence tools to ease and improve the creation process of digital educational escape rooms. In other words, this paper provides examples of how elements of digital escape games (such as narrative, game environment images, and puzzles) can be created with generative artificial intelligence tools (e.g., ChatGPT, Bing Image Creator, Stable Diffusion, AutoDraw, etc.).

Keywords: digital game development, educational escape rooms, generative artificial intelligence, game-based learning, technology-enhanced learning

Field: Social Sciences and Humanities

1. INTRODUCTION

The first real (recreational) escape room, outside the realm of video games with a similar concept, appeared in Japan in 2007 and soon these games became popular for entertainment and team-building purposes in other parts of the world, especially in Europe (Nicholson, 2015). In the literature, escape rooms used in educational environments are usually called educational escape rooms. It is reasonable to assume that the development and use of educational escape rooms started spontaneously (bottom-up) when enthusiastic teachers (familiar with the concept of recreational escape rooms) adapted these games for use in their classrooms (Grande-de-Prado et al., 2021; Repetto et al., 2023; Veldkamp et al., 2020, 2021). Educational escape rooms can be defined as cooperative games designed for teaching specific educational content based on a series of puzzles (connected with narrative and clues) that group(s) of pupils/students have to solve in a limited amount of time in order to successfully complete the game and "escape the room" or alternatively break into the locked box or unravel a mystery (Grande-de-Prado et al., 2021; Reuter et al., 2020). According to Grande-de-Prado et al. (2021), the main benefits (advantages) of the use of educational escape rooms that have been pointed out in the literature are improved problem-solving skills, collaborative teamwork, enhanced social competence, and increased motivation for learning. A systematic literature review (based on 39 studies) conducted by Veldkamp et al. (2020) on educational escape rooms has shown that the majority of students in all analyzed studies enjoyed the activity and were highly engaged. Still, the effects of these games on gaining content knowledge stayed unclear since only three studies used pre-and post-test research design to measure knowledge gains, and only one study reported some improvement in students' content knowledge (Veldkamp et al., 2020). In a study carried out by Veldkamp et al. (2022), about the contribution of an educational escape room game to knowledge acquisition, the post-test results were significantly better than the pre-test results. The same authors reported that immersion directly influenced knowledge gain and that a narrative (used in this educational escape game) helped evoke immersion.

The use of digital educational escape rooms in primary, secondary, and tertiary education gained

*Corresponding author: ivan.stojasic@bio.bg.ac.rs



significant popularity during the shift to online teaching caused by the COVID-19 pandemic (Ambrožová & Kaliba, 2021; Makri et al., 2021; Repetto et al., 2023). Digital educational escape rooms can be described as escape game-like immersive and interactive activities (related to specific educational content and learning objectives) made with digital technologies. Makri et al. (2021) conducted a systematic literature review regarding the use and effects of digital escape rooms in educational environments. They included 45 studies and the results showed that digital educational escape rooms can positively impact students' learning performance. Additionally, the results indicated that these games promote collaboration, cooperation, and communication, can enhance problem-solving and higher-order thinking skills as well as can improve students' engagement, motivation, and satisfaction (Makri et al., 2021).

We should bear in mind that the most important part of the educational escape game is design and that teachers should be knowledgeable of game design principles as well as learning design approaches (Grande-de-Prado et al., 2021; Repetto et al., 2023). In other words, teachers should integrate and blend both game-based and pedagogical principles in order to create high-quality educational escape rooms (Repetto et al., 2023). According to Makri et al. (2021), using digital technologies for designing educational escape rooms is still a young field. However, there is a growing body of literature that focuses on design frameworks (models) and design principles of physical, hybrid, and digital educational escape games (Botturi & Babazadeh, 2020; Clarke et al., 2017; Grävellsina & Daniela, 2021; Guigon et al., 2018; Moffett & Cassidy 2023; Repetto et al., 2023; Reuter et al., 2020; Veldkamp et al., 2020). Additionally, Repetto et al. (2023) proposed an evaluation tool (composed of five requirements: usability, pedagogical soundness, internal coherence, creativity, and engagement level) that can guide teachers during the development process of digital educational escape rooms. Still, Reuter et al. (2020) pointed out that many studies have reported that teachers and other educators were in many cases unaware of strategies for creating effective educational escape rooms. Therefore, the main problem in practice is that primary and secondary school teachers are often not familiar with game design principles, and rarely implement proposed models, frameworks, and evaluation tools when creating digital or hybrid escape games for their classes. Training programs for teachers should be provided since not all teachers who want to develop escape games have the necessary skills and knowledge to design effective ones (Hakshurian, 2023).

Teachers and other educators usually use free online tools and applications to develop their digital escape games (Kroski, 2020a). Google Slides, Genially, Thinglink, Google Sites, Canva, Google Forms, LearningApps, Flippity, and Padlet are indicated in the literature as the main tools used by teachers (and future teachers) for creating the game environment, locks, and puzzles (Ambrožová & Kaliba, 2021; Repetto et al., 2023; Şahin, 2023). Generative artificial intelligence (AI) has transformative potential in the domain of education and many teachers may find AI-based tools helpful (Cooper, 2023). There is already a significant number of papers discussing the affordances, benefits, limitations, and practical applications of new generative AI tools (such as ChatGPT) for different educational purposes (Cooper, 2023; Hadi Mogavi et al., 2024; Pérez Colado et al., 2023). According to Pérez Colado et al. (2023), in educational (serious) game development, AI can be used for a variety of tasks (for creating high-quality graphics, game narrative, etc.), thereby lowering the entry barrier for educators to prototype their digital educational games. The aim of this paper is to show how teachers can utilize generative AI tools (ChatGPT, Bing Image Creator, Stable Diffusion, etc.) to improve and ease the creation process of digital educational escape rooms.

2. NARRATIVE AND GAME ENVIRONMENT

After defining learning objectives, a game narrative (storyline) should be crafted (Reuter et al., 2020). Escape rooms rely on a story (narrative) to encourage active participation, foster participant (student) engagement, and enhance the attractiveness of the escape game (Ambrožová & Kaliba, 2021). According to Nicholson (2018), educational escape rooms are about the student experience and the story since narrative-based challenges encourage pupils/students to learn more, reflect upon connections between learning materials and their own lives, and foster their motivation for exploration and further knowledge-seeking. In other words, educational escape games should be based on a narrative-driven approach and include a story as an introduction to the game. However, in the study conducted by Ambrožová and Kaliba (2021), 9% of analyzed digital educational escape rooms created by teachers in the Czech Republic didn't include any specific narrative and in 45 (out of 107) games narrative was used insufficiently since the individual tasks (puzzles) concluded without a continuation or progression in a storyline or overarching plot. The same authors indicated that some digital escape games felt more like online worksheets (due to missing narrative) as well as that some games included narrative in a disputable way. The conclusion can be drawn that many teachers lack the necessary skills and knowledge to craft meaningful and engaging

narratives for their digital escape room games.

AI tools such as ChatGPT can generate stories and support the development of the game narrative (Pérez Colado et al., 2023). Therefore, ChatGPT can offer valuable assistance to teachers in the process of crafting narratives for their digital (or hybrid) educational escape rooms. Figure 1 shows one introduction narrative for a digital educational escape room that is co-created with ChatGPT through several iterations.

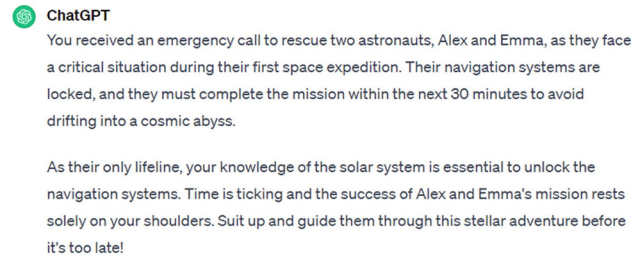


Figure 1. An example of a ChatGPT-generated introduction narrative for the digital educational escape room
Source: ChatGPT (version 3.5)

Some teachers struggle to find suitable and free visuals (photos, illustrations, etc.) for their digital escape games, as well. Additionally, finding appropriate images can be a very challenging and time-consuming task. According to Pérez Colado et al. (2023), generative AI tools (such as Stable Diffusion) could provide graphic resources for educational games. The same authors also indicated that AI-generated backgrounds can provide a more cohesive and coherent game environment. Besides Stable Diffusion, teachers can use similar generative AI tools such as Bing Image Creator and TinyWow AI Image Generator for free for creating AI-generated images based on textual (descriptive) prompts. For making drawings and illustrations teachers can use a free AI tool called AutoDraw. Figure 2 presents a digital escape game made with AI-generated background images.



Figure 2. Digital escape game "My First Space Mission" (for a 5th-grade Geography lesson)
Game creator: Ivan Stojšić

Pérez Colado et al. (2023) also suggested fine-tuning the prompt for optimal results and generating a lot of backgrounds then picking the best ones.

3. PUZZLES

The following action after crafting the narrative is to develop puzzles (Reuter et al., 2020). Puzzles are the main components of educational escape games (Guigon et al., 2018). In an escape room, all its challenges, problems, and tasks are called puzzles (Makri et al., 2021). Puzzles need to be related to the theme and narrative of the game (Clare, 2015), and in an educational escape room, they should also be aligned with the curriculum (Veldkamp et al., 2020). Designing effective puzzles is challenging since easy puzzles may lose their appeal and become boring, while puzzles that are too hard for students can cause frustration (Makri et al., 2021). Well-designed puzzles keep players (students) from experiencing

frustration or boredom (Reuter et al., 2020). In other terms, puzzles should aim to induce the flow state (Csikszentmihalyi, 2008; Repetto et al., 2023).

Kroski (2020b) explained how educators can use free online tools to create different types of puzzles (such as word games, quizzes, ciphers, jigsaw puzzles, etc.) and digital clues. In their paper, Moffett and Cassidy (2023) included the puzzle reflection template (comprised of eleven questions) that can be used for outlining puzzle characteristics (features). Also, some tools (such as Genially) provide templates for creating digital escape rooms (Grande-de-Prado et al., 2021). On the one hand, Genially templates are easy to use and can speed up the process of developing digital escape games. However, on the other hand, they provide only repetitive multiple-choice questions as puzzles. Therefore, the usability of such templates is questionable since digital educational escape rooms should include a diverse range of puzzles (not just one type). Additionally, Repetto et al. (2023) pointed out that quiz-type or fill-in-the-blank exercises might not be suitable (as puzzles) in digital escape games if a learning objective indicates the application of a concept or from the constructivist approach.

According to ChatGPT, ChatGPT can generate riddles, crossword and word games, quizzes and trivia questions, cipher challenges, logic and pattern recognition puzzles, geography-related quests, and similar puzzles characteristic for educational escape rooms. Hence, ChatGPT can assist teachers in crafting engaging narrative-driven puzzles for digital (or hybrid) escape games. Still, clear and specific prompts tend to yield more accurate and relevant output from ChatGPT. Also, teachers should critically evaluate any ChatGPT-generated content and adapt it to their needs (Cooper, 2023). Figure 3 shows one puzzle co-created with ChatGPT through several iterations.

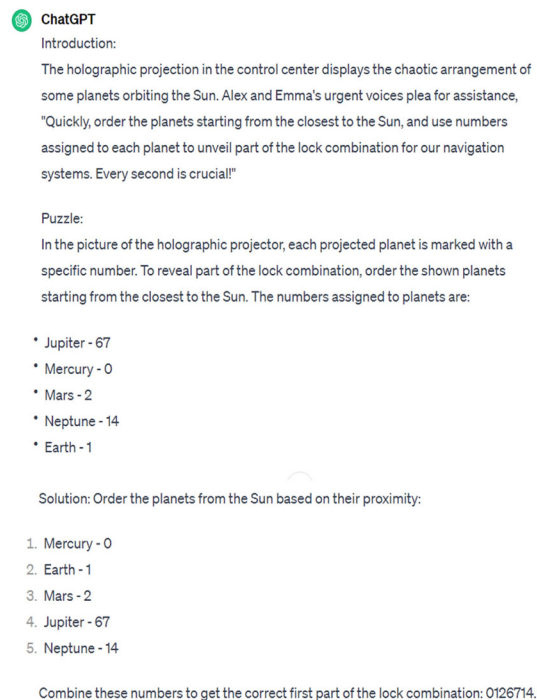


Figure 3. An example of a ChatGPT-generated puzzle for the digital educational escape room
Source: ChatGPT (version 3.5)

In the end, it is useful to visualize the layout of the escape game and examine how well puzzles connect with each other (Moffett & Cassidy, 2023; Reuter et al., 2020).

4. CONCLUSIONS

Digital educational escape rooms gained significant popularity during the shift to online teaching caused by the COVID-19 pandemic. The literature implies that digital educational escape games could potentially foster and support knowledge acquisition and improve students' social, critical thinking, and problem-solving skills, as well as their engagement and motivation for learning. Still, if digital educational escape rooms lack cohesive graphics, engaging and challenging puzzles (developed for specific learning goals), and compelling narratives, we cannot expect any substantial positive impact on students' learning experience, motivation, and achievement. This paper points out how teachers can use generative AI tools

to ease the creation process of digital escape games as well as how these tools can improve the quality of game content. We should be mindful and acknowledge that the adequate quality of digital educational escape rooms is a necessary requirement for meaningful and effective integration of this type of game-based learning in real and virtual educational environments. Additionally, teachers should be trained in game design principles and how to utilize generative AI tools when creating digital or hybrid escape games for their classes.

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