

Educational Escape Room for Disaster Preparedness and Response Training

Ioannis Kazanidis¹, Gotzamanis Vasilios¹, Panagiotis Fotaris² and Augoustos Tsinakos¹

¹ International Hellenic University, Greece

² University of Brighton, Brighton, UK.

kazanidis@teiemt.gr

gojibil@gmail.com

p.fotaris@brighton.ac.uk

tsinakos@cs.ihu.gr

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Abstract: Human-made and natural disasters are constantly occurring, and citizens need to be aware of their protection. Although disaster education is considered an important aspect of disaster preparedness, it relies mostly on conventional lectures given by experts on disaster prevention. However, a fundamental problem of this method of delivery is that lectures are based on the information transmission fallacy, the idea that students learn just by being told. Although lectures may increase risk perception, they do not automatically enable youth to know the importance of pre-event preparations and to take action to reduce disaster risk. To overcome the key obstacle of lack of motivation, this study proposes an alternative approach to lecturing – active learning activities using escape room concepts. This paper provides considerations for researchers and organisations concerning the development of a portable educational escape room about disaster preparedness. A total of 84 young adults aged 13-20 participated in a 30-minute escape room activity and postgame debriefing. An attitude questionnaire and focus groups were used to evaluate student experience in terms of satisfaction, quality of the escape room, and the impact of the escape room on learning. Most participants found their experience very engaging and reported that the game helped them gain new knowledge about fire safety and disaster response. These findings suggest that the escape room intervention can be used as a potential avenue to facilitate learning and increase disaster preparedness and response knowledge.

Keywords: Educational escape room, Breakout box, Game-based learning, Disaster preparedness, Disaster response training.

1. Introduction

Natural disasters and the people affected by them have exponentially increased in recent years (Codreanu et al., 2014), producing devastating effects for people who may suffer mentally or physically, lose their property or even their lives. This includes children, with 5-43% of affected children experiencing posttraumatic stress disorder (PTSD) and many of them suffering from depression, anxiety, and other mental health effects (Kar, 2009). The number of affected children makes it imperative to foster resilience and preparedness ahead of disasters among this group.

Although disaster education for children and young adults is considered an important aspect of disaster preparedness, it mainly includes lectures by experts on disaster prevention. Unfortunately, this lack of interactivity and hands-on experience usually turns children into passive recipients, thus making it harder for them to understand how to respond and cope with a particular event. For this reason, we propose their participation in interactive learning experiences such as educational escape rooms that have the potential to make children active participants in knowledge production and acquisition. This way they will be able to better assimilate what they have to do before and during a disaster and therefore improve their preparedness and resilience. Their actions may save human lives and prevent a potentially dangerous natural phenomenon such as an earthquake turn into a disaster.

Escape Rooms have been used commercially for entertainment since 2009. However, educational institutions and libraries have only recently started to integrate them into their programmes for educational purposes (Walsh and Spence, 2018; López-Pernas et al., 2019). Research studies have found that escape rooms can act as a valuable game-based learning tool which can be effective for students in various domains when designed appropriately (Fotaris & Mastoras, 2019). Additionally, providing a shared environment for players to work together on a game designed around specific learning outcomes can potentially set the groundwork for active learning. This paper introduces the use of escape rooms for disaster preparedness and response training. Its main aim is to evaluate the effectiveness of this novel approach as an engaging educational tool.

2. Background

Lecturing remains one of the most employed tools for information transmission in education; a teacher / 'sage on the stage' resides in front of a class, talks, and shows slides while students listen and take notes. However, conventional lectures are effective only to a limited extent in attaining important curriculum objectives, as they do not promote critical thinking, thus leading to poor student attendance and low cognitive engagement (Schmidt et al., 2015). Additionally, many 21st century school classrooms still have a similar appearance to that of a classroom located in the Victorian era. With that in mind, education may be seen by young people as dull and outmoded, and perhaps because of this stance schools face problems with the motivation and engagement of their pupils (Wells & Fotaris, 2017). However, using game-based learning approaches in the classroom can contribute to this argument and help improve student engagement, motivation, collaboration, and inevitably their learning (Silveira, 2018; Yusoff et al., 2018).

Borrowing aspects from several motivational models (e.g., ARCS Model, Malone's Theory of Intrinsically Motivating Instruction, Lepper's Instructional Design Principles for Intrinsic Motivation, The Taxonomy of Intrinsic Motivation, Operant Conditioning, Self-Determination Theory, Distributed Practice, Scaffolding, Episodic Memory, Cognitive Apprenticeship, Social Learning Theory, Flow) (Kapp, 2012), a gamified learning experience can re-captivate students and provide a beneficial break without producing any detrimental effects, thus offering a whole new set of opportunities to make students more involved, engaged, and motivated (Fotaris et al., 2016). Additionally, the competition and collaboration involved in games allow students to interact with their peers in order to gain new knowledge and skills, which can result in improved academic performance. This concept of working as a team to achieve a common goal is prevalent in escape rooms where players must collaborate in a race against time to solve puzzles and win the game. Therefore, escape rooms can potentially be used for educational purposes, as they allow students to collaborate and construct their own knowledge based on real-time experiences of advancing through several challenges in the game.

2.1 Educational Escape Rooms

Despite being a relatively new concept, escape rooms have become immensely popular in recent years. They were firstly used in Japan in 2007 and grew rapidly in the last 5 years, exploding from 2,800 rooms throughout the world in 2015 to over 7,200 in 2018 (Kroski, 2019). Escape rooms are one type of *escape games*, which are narrative-based challenges utilising puzzles, tasks, and a time limit. Other types include puzzle hunts, breakout boxes, escape books, Augmented/Virtual Reality (AR/VR) escape rooms, or portable escape-rooms-in-a-box where most of the puzzles are contained in a box or even in postcards so that players can have the same immersive and challenging experience in the comfort of their home (Fotaris & Mastoras, 2019).

Although primarily considered a leisure pursuit, the skills utilised in an escape room – delegation of tasks, communication, critical thinking, attention to detail, problem-solving, and lateral thinking – are a close match to the top 10 skills for high-paying jobs by 2020 as identified by the World Economic Forum (Gray, 2016). Escape rooms also take advantage of the players' spiritual skills, so they are a good fit for the classroom environment (Nicholson, 2018). Moreover, the structure, interactivity, and opportunity for collaboration found in escape rooms allow educational scenarios to be developed for playful learning (Clarke et al, 2016).

An educational escape room/game can be defined as "*an instructional method requiring learners to participate in collaborative playful activities explicitly designed for domain knowledge acquisition or skill development so that they can accomplish a specific goal (e.g., escape from a physical room or break into a box) by solving puzzles linked to unambiguous learning objectives in a limited amount of time*" (Fotaris & Mastoras, 2019). It provides a creative learning environment that can be set up in any educational setting (e.g., school, youth centre, library, kindergarten, camp) or even online. From a pedagogical point of view, escape rooms are based on a social-constructivist approach (Vygotsky, 1978). Learners are called to face new and often complex problems, which can be solved by interacting with their peers and getting support from their tutor. Academically focused escape-style scenarios were popularised by *Breakout EDU*, an immersive learning games platform founded in 2015 that provides escape room kits ('breakout boxes') for instructors (Rouse, 2017).

2.2 Educational environments for disaster preparedness and response

The last 5 years have seen the development of an increasing number of educational escape rooms with satisfying results, such as improved communication, collaboration, engagement, and student satisfaction (Friedrich et al., 2018). However, due to their novelty, studies on empirical work or the educational significance of such activities

in the field of disaster response is still limited. Although there have been many efforts to transmit knowledge to children (e.g., the European Emergency Number Association runs several public awareness campaigns each year, as awareness of the '112' emergency number can be a lifesaver in various cases and incidents such as car accident, work accident, fire, explosions, earthquake etc.), information-based education still remains the most popular approach despite criticisms that conventional lectures do not add much to student learning and sometimes may even be detrimental to their learning (Schmidt et al., 2015). A notable exception includes the "Look at the label: for the safety of young people" campaign (CECU, 2018), which aims to reduce the number of exposure and poisoning of children in Spain by informing those who take care of children about the importance of reading product labels, as well as the safe use and storage of these products.

Studies have shown that conventional methods of communicating natural hazards risk through factual information in brochures and lecture-style presentations are not as effective in inspiring preparedness actions as novel, interactive approaches that directly engage participants (Novak et al., 2019; Whitney et al., 2004; Wood et al., 2012). Since these passive communication methods are unlikely to provoke a sense of personal relevance to motivate preparedness actions (Sattler et al., 2014), video games have been used as an alternative interactive method. One such game is "Disaster Master" where players can browse and learn about disaster management. There are eight levels in the game that require players to face a different disaster, such as a fire, tornado, hurricane, cyclone, etc. and answer relevant questions (DHS, 2018). Jenkinson and Macleod (2012) also reported positive results when using an interactive in-person game to help students understand vulnerability to extreme events.

Two more educational games developed as learning tools for the prevention and response to disasters are "The emergency suitcase" (Panagiotopoulou et al., 2017) and the "House of Disasters" (Kazanidis et al., 2019). The first one teaches children how to prepare an emergency suitcase as a precautionary action before an earthquake, which can potentially prevent an earthquake become a disaster and cost human lives. Similarly, "The House of Disasters" teaches children the necessary survival actions to follow before, during and after a dangerous phenomenon or an emergency, such as an earthquake, flood, or fire while they are at home. Both studies that utilised these games concluded that game-based learning approaches can lead to actual behavioural changes, thus having a positive impact on disaster prevention and response.

Despite including other ways of learning than the traditional teacher-to-student, passive knowledge-acquisition format, the aforementioned examples are single player experiences with limited interactivity which rely mostly on theoretical knowledge. Since an individual's resilience is not only a matter of theoretical knowledge, but also calls for many forms of learning (visual, verbal, logical, mathematical), organisational skills, spatial thinking and accurate decision making (Codreanu et al., 2014), educational disaster interventions may be more effective if they take the form of an educational escape room.

Novak et al. (2019) developed an earthquake-themed escape room as part of a campus-wide preparedness event. Post-test results showed that earthquake reaction knowledge and knowledge of mitigation strategies were high, which was attributed by most participants to the interactive escape room, therefore suggesting that the escape room intervention has potential for increasing disaster preparedness knowledge among college students. Inspired by this project, the current paper proposes an interactive intervention that uses the escape room format to engage students in disaster preparedness and response activities.

3. Methodology

The purpose of the escape room was to create an immersive learning experience that would help participants gain basic knowledge, develop right attitudes and be prepared to perform certain actions in the event of natural disasters or emergency situations. Specifically, learning outcomes included identifying fire extinguishers by their colour-coded system and understanding their suitability for different types of burning media, identifying '112' as the single European Emergency Number for calling the emergency services in the European Union, and learning the meaning of the international Globally Harmonized System of Classification and Labelling of Chemicals (GHS) hazard pictograms.

84 students aged 13-20 were split into 14 teams of 6 and took the role of Civil Protection trainees whose main duty was to deal with disasters. At the beginning of the game, they received a briefing in the form of a short animation which informed them that they had to complete the last stage of their training to become Civil Protection officers. This included gathering information about fire threats and how to respond to fire

emergencies, as well as informing others how to function effectively during times of emergency and disaster. According to the game’s scenario, each team had to arrive at the point where hazards had occurred, extinguish fires that had broken out, deal with dangerous chemicals, and finally call for reinforcements within a time limit.

The game took place in a single large room. As it was not feasible or legal to lock participants in and wait until they puzzled their way out as they would do in a typical escape room, it was decided to use the concept of “breakout boxes”, i.e., players had to work together and think critically to “break into” locked boxes. While this type of activity lost the complete immersion of a true escape room, it still provided a motivating and educationally beneficial experience according to student feedback. The BreakoutEDU kit that was used made the game portable and easy to set up, too. Custom-made props were also used for some of the puzzles.

Due to logistical constraints the duration of the activity had to be limited to 30 minutes per team, so after some testing participants were given 3 minutes for briefing, 15 minutes of gameplay, and 12 minutes for debriefing. To ensure that the available time would be enough, the complexity of the game was reduced by using 3 linear puzzles, with each one being a separate ‘mission’ that players had to complete to win the game. Solving one clue would give players the object to solve for the next clue etc., meaning that the whole team would be working on a single puzzle at once, which is considered good practice building teamwork amongst 6 people.

The first puzzle (“Firefighting”) aimed to familiarise participants with fire extinguishers and their types. They were asked to place fire extinguishers in a specific order and choose the appropriate extinguishing material according to the type of fire they had to deal with (Fig. 1). The order of fires was indicated on a clue card they had been given at the beginning of the game. By placing the fire extinguishers in the right order, players would find a four-digit code written on the extinguisher’s bottom that they should use to unlock a box and get the clue to the next puzzle.



Figure 1: Extinguishers with their labels

The goal of the second puzzle (“Calling Emergency”) was to inform players about the European emergency number. According to the game scenario, they had to deal with a number of emergencies all over Europe. By placing a punched card over a map lit by a UV torch players would reveal the number “112”, which was the combination to unlock another box and get the clue to the final puzzle (Fig. 2).



Figure 2: Props used for the “Calling Emergency” puzzle

For the third and final puzzle (“Hazard Pictograms”) players had to identify the GHS hazard pictograms that alert users of the chemical hazards to which they may be exposed. Specifically, they had to match the pictograms to their meaning in order to get a five-colour sequence. The latter should be used to unlock a colour combination lock and open the final box to win the game (Fig. 3).



Figure 3: Hazard pictograms puzzle

While participants played the game, moderators closely monitored their actions and provided hints when needed. The time limit and game difficulty proved to be well-balanced as all teams managed to solve the puzzles with only a few seconds to spare and win the game. At the end of the activity there was a team photoshoot and all winners were awarded with commemorative wristbands.

The authors designed an intervention that utilised interactive escape room concepts as an event to enhance disaster preparedness. The goal of the event was to engage as many participants as possible in the activities in a short amount of time. For that reason, there was concern that the administration of a pretest/posttest questionnaire would slow down the implementation of the activities and add to the time burden for participants. As a result, it was decided that a nonexperimental design focusing on debriefing was more practical. Debriefing is an integral part of a game-based learning experience as it fosters reflection and metacognition, and also allows students to become aware of the learning elements (Sanchez & Plumettaz-Sieber, 2019). Therefore, after the conclusion of the escape room participants attended a 12-minute debriefing which included a focus group discussion, an attitude questionnaire, and a postgame educational animation. This session was used to gather information about the participants’ overall experience, inform them on the purpose of the game, provide them with insight into the activity in order to help them learn from their experience, and allow for a dialogue on

anything that might have been confusing during the game. The results from the debriefing would help answering the following research questions:

- RQ1: What is the participants' opinion about the quality of the escape room?
- RQ2: Can escape rooms be an engaging educational tool to inform and educate players on disaster preparedness and response?
- RQ3: How satisfied were participants with their escape room experience?

4. Results

A total of 84 students (male = 40, female = 44) aged 13-20 ($M = 15.7$) played the escape room and all of them attended the postgame debriefing session and filled in the attitude questionnaire comprised of 14 questions that used a 7-point Likert scale (1 = Totally disagree, 7 = Totally agree) (Table 1).

Table 1: Summary of attitude questionnaire results ($N = 84$)

Questionnaire results	Mean	SD
<i>Escape room quality</i>		
Q1. Props and puzzles were simple to use	5.0	1.7
Q2. Props and puzzles were creative	5.5	1.3
Q3. Props and puzzles were engaging	5.3	1.5
Q4. Props and clues were easy to interact with	5.3	1.8
Q5. Props and puzzles were of good quality	5.4	1.7
<i>Effectiveness of escape room for disaster preparedness and response training</i>		
Q6. Escape room was an engaging educational tool	5.9	1.3
Q7. Escape room is preferable to conventional lectures	5.5	2.0
Q8. Escape room helped me learn faster	6.1	1.3
Q9. Escape room helped me learn better	6.0	1.3
Q10. Escape room helped me cover more learning material	6.0	1.3
Q11. Escape rooms could be used for teaching other subjects	6.2	1.1
<i>Participant satisfaction</i>		
Q12. Activity was enjoyable	6.0	1.2
Q13. Activity was educational	6.1	1.4
Q14. Activity was satisfactory	5.9	1.3

Regarding RQ1, findings suggest that participants were overall satisfied with the quality of the escape room. Participants found the custom-made props and clues used for the puzzles throughout the game to be simple (5.0), creative (5.5), engaging (5.3), and easy to interact with (5.3).

For RQ2 participants were asked to rate the escape room in regard to how effective they found it for disaster preparedness and response training. The majority considered escape rooms an engaging educational tool (5.9) and preferred them to conventional lectures (5.5) as they believed that this novel approach allowed them to learn faster (6.1), better (6.0), and cover more learning material while playing (6.0). Additionally, participants stated that escape rooms could be used for teaching other subjects (6.2). These findings corroborate prior research that found learning methods to emergency preparedness to be more effective than written materials and lecture-based methods (Novak et al., 2019; Becker et al., 2012).

Finally, for RQ3 participants were asked to rate the escape room in terms of player satisfaction. Like before, mean scores for all assessed categories were above 5, with the majority of participants finding the activity enjoyable (6), educational (6.1) and satisfactory (5.9).

To get extra insight into the questionnaire results, qualitative research was conducted in the form of focus groups during the debriefing session. Participants expressed their excitement about the whole experience and asked if there were similar educational escape rooms that they could try, while some of them requested to play one more time and wished that the game was longer. Additionally, participants were competitive about their game completion time and also discussed the way they solved the game puzzles with their peers from other teams, which made their whole experience more motivating and engaging for them. As demonstrated by the following sample of responses, the overall reaction by interviewees was extremely positive and confirmed the aforementioned results:

- “It was very exciting to try to solve the escape room puzzles under time pressure.”
- “I think this is a very motivating way to learn.”
- “I wish all courses could employ this type of educational activities as they make learning easier.”
- “This was a very enjoyable experience. I never thought that learning about disaster preparedness could be such fun.”

Additionally, participants stated that they would read more about disaster preparedness as a result of the game and believed that the escape room exposed them to collaborative teamwork and created team spirit. They also found both the available time and the puzzle difficulty levels appropriate. Finally, all participants would recommend this educational escape room to a friend.

5. Discussion and Conclusion

The present study explored how the use of an escape room for disaster preparedness and response training could affect the learning experience and the participants’ motivation and engagement. Despite the limitations of small sample size, short game duration, and lack of pretest/posttest evaluation to document gained knowledge, results from the debriefing suggest that using a game-based learning approach has successfully achieved the pedagogical goals outlined in the introduction, thus providing evidence of feasibility and acceptability of the intervention. Based on the concepts of the increasingly popular escape rooms, it gave participants the opportunity to experience first-hand how game mechanics could be used to disseminate knowledge of disaster preparedness and response in a fun and collaborative way. The overwhelming satisfaction reported by participants indicates that educational escape rooms have the potential to help learners understand the value of seeing problems from different perspectives, expose them to collaborative teamwork, promote engagement and persistence on task, strengthen social relationships, and facilitate benefits of deep learning through group discussion.

However, designing puzzles that address specific learning objectives and force participants to engage with the material instead of just searching for clues requires a significant amount of time and thought. Educators will need to dedicate time to develop facets of the escape room such as its theme or narrative, creating a variety of puzzles, using and implementing hints, producing engaging briefings, organising debriefings, and writing instructions for resetting the room between trials. Building custom props can also be a challenging, expensive, and time-consuming task, as well as using audio or video surveillance equipment to record participants and collect user data as they complete the room. Furthermore, escape rooms need to be thoroughly tested before they become available to the public in order to estimate the time required to complete the game and identify any errors that could prevent the successful completion of the game. Once the escape room has been developed though, it can be used repeatedly in successive years. Finally, rigorous evaluation including pre- and post-tests is needed to confirm the educational value for different designs, different types of content, and in different settings.

Despite the successful pilot study, future work is required to produce more reliable results. This includes testing the intervention in an experimental trial utilising a pretest, posttest, and delayed posttest administered 2 or more weeks after the game to measure retained knowledge. Larger sample sizes, more puzzles and different preparedness and public health messages are also necessary to determine the game’s efficacy as a general education method. New technologies such as Augmented Reality could also be used for puzzles in order to facilitate a more immersive experience.

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