

# Escape Rooms for STEAM Education: Comparing Design Phases

Zoi Karageorgiou<sup>1</sup>, Panagiotis Fotaris<sup>2</sup> and Eirini Mavrommati<sup>1</sup>

<sup>1</sup>Hellenic Open University, Patra, Greece

<sup>2</sup>University of Brighton, UK

[zoikara@hotmail.com](mailto:zoikara@hotmail.com)

[P.Fotaris@brighton.ac.uk](mailto:P.Fotaris@brighton.ac.uk)

[mavrommati@eap.gr](mailto:mavrommati@eap.gr)

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**Abstract:** The use of Escape rooms in education shows a constantly increasing rate, since schools need to operate with different paradigms of learning. Teachers often incorporate such live action games in their practice either as formative assessment tool or as a method for experiential, peer-group, game-based learning. In vocational schools it's important to encourage and motivate students in order to help them find their professional rehabilitation. This paper addresses the design phases that took place at a vocational school in Greece during the development of two different escape rooms. As part of their Creative Activities Zone (CAZ) classes, 12 STEAM students created a Christmas-themed Escape room for a local council. This project was built upon another escape room developed at the same school the previous year by 39 multi-disciplinary students. In both games, one student took the role of a non-player character (NPC) and interacted with the players throughout the game. This article presents and compares the design stages for the aforementioned action plans in order to assist educators and other stakeholders with incorporating escape rooms into their teaching practice. Designing escape rooms that combine technology, creative writing and drama games, can offer students opportunities to think outside the box, develop problem-solving, decision making, and strategic planning skills, as well as become useful citizens to their local community.

**Keywords:** escape room, design, education, technology, creative writing, theater

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## 1. Introduction

STEAM education provides many opportunities for students to improve themselves in several areas, since they increase the appeal of subject areas and promote creativity (Souza & Pilecki, 2013). STEAM projects combine art and creativity with the knowledge of STEM (Science, Technology, Engineering and Mathematics) disciplines and bring the variety and diversity that are requisite for innovative product design and development (Oner et al., 2016). STEAM Education continues to grow in popularity, but with limited extant research to define effective teaching practices (Herro & Quigley, 2016).

Subia (2018) in her study concludes that teachers should accommodate education process by developing useful but not conventional strategies, intelligent schemes and creative tactics to achieve their goal. An innovative educator changes up a lesson to make it more engaging, increase the enjoyment of learning, challenge students and develop a rapport based on understanding and good communication. Furthermore he takes advantage of the opportunities provided by the structure of some more flexible courses in order to use the abilities and talents of the students and increase the possibilities of his success. Educators have to foster both problem solving and problem seeking skills, while maintaining the interest of the students (Land, 2013).

Play, according to Rowe (1992) is a fascinating, enjoyable and captivating activity that requires mental or physical engagement in the pursuit of anticipated awards (Grayson, 1999). It promotes creativity, imagination and spontaneous learning (Lieberman, 1977), supports learning from failure, management of risk-taking (Whitton, 2018) and allows students to build on and broaden precedent knowledge and skills (Ashiabi, 2007) and to construct relationships and realities (Salen and Zimmerman, 2004) during their interaction with others and the environment.

In order to establish a culture of innovation and creativity in schools, students should shift to active creators of knowledge (Rice, 2000). One way to do that is through escape games, because this type of activity is engaging, it stimulates critical thinking and problem-solving skills, it activates team spirit, and gives each participant the "flow" feeling and satisfaction (Nicholson, 2015). Their pedagogic use keeps rising and they are already used in education for a variety of subjects (Dietrich, 2018), since they acquire with a sterling collaborative context and created puzzles can meet set curriculum goals (Clarke et al., 2017). Escape rooms give a further boost to many valuable skills of the students and this results in the increment of their use for educational purposes (Lopez-Pernas et al., 2019). Williams (2018) observed the use of active listening skills, effective conflict management

and efficient interdependent methods between students in his projects. Batzogiannis et al. (2018) indicate that students' engagement with co-creation of an escape room helped them discover and realize what they learn in STEM informal classes and enhanced their motivation towards STEM.

Vocational schools try to follow technological changes, equip students with special skills and have access to the most up-to-date technologies. The economic climate of austerity has limited financial resources, so it's uneasy to respond to new and innovative challenges (Cedefop, 2018, a). "New beginning at EPAL", is designed to upgrade the role and image of Vocational Education in Greece and it includes actions that give priority to students' and society's needs and improve the school environment (Cedefop, 2018, b). According to the Greek's Government Newspaper (Minedu, 2017) it supports designing action plans that link Vocational institutes with local communities and establish collaboration with the greater educational and scientific society. These action plans can include STEAM, social, entertainment or cultural projects and provoke teachers to use active, participatory and experiential learning methods in their lesson. In order to be implemented they are co-financed by Greece and Europe. The institution that is responsible for the whole project is Noesis (Science Center and Technology Museum of Thessaloniki).

The Creative Activities Zone (CAZ) is a three hour course based on the principles of experiential approach. It enables the school professor to design a set of educational activities based on the needs and interests of both pupils and the local community. This innovation is based on reforming the lesson plan and fostering a collaborative approach to learning. It aims to develop the student's critical thinking, collective effort and experiential action through action plans specifically designed for the participants. It also aims at establishing an enjoyable and creative environment where learning and teaching are not treated as passive acceptance of fragmented knowledge. CAZ primary aims at the exploitation of pupils' ideas and their creative expression, their mental development, the integration of their personality and the cooperation between the members of the school community. It also provides the opportunity to cultivate the particular abilities and skills of pupils, to raise their awareness of issues of general social interest and to develop a collective spirit. Finally students can engage in multifaceted activity and can create a diversity of events to connect the school with the local community. During the projects teachers can be informed for additional teaching material that they can use, training opportunities, integration into local, national, European and international thematic networks, competitions and all opportunities that can be used to their advantage of pupils and school units. (IEP, n.d).

## **2. Aims**

The purpose of this paper is to present the design phase of two escape room projects that took place in a Vocational school in Greece. They were set and implemented in separate periods of time by different teams of students and professors. It's worth mentioning though that the second game was based on the acquired experience of the teacher who organized the first one and the students who implemented it initially participated as players in the first escape room project of the school.

The basic aim of the paper is to shed light on the framework used for:

- the co-creation of an alternative escape room called "La casa de Papel Escape Room", where students' creativity led into a successful STEAM project that included the transformation of computer class into a live-action game environment using technology, creative writing and theatre elements and Experience Pyramid Model tool.
- the co-creation of a Christmas escape room called "Home Alone 2 Escape Room". The organizational committee of the Christmas Village of the Municipality asked students of EPAL Aiginou (Vocational School of Aiginio in Greece) to transform one of the mini-houses in the Christmas Santa Claus Yard into an escape room. Cooperation with the Parents and Guardians Association was beneficial and outstanding.

The description of the design methodology, comparisons and observations will help educators, scientists and anyone else interested in conducting such a project.

## **3. La casa de Papel design**

Based on the results of the inquiry 9 students from 4 specialties of the school were selected to use their knowledge, their fantasy and their abilities in order to design an escape room in EPAL Aiginou. They should be prepared and positive to cooperate with the 21 students of A' Class, as tutors, in order to show them how a

knowledge gained from each field can be used enriched and linked to personal experiences, so to create a project that can potentially be a future professional goal. Also, 10 teachers from different specialties discussed about the subject and agreed to help this project to be implemented. The students of A' Class were separated in groups such as actors, programmers, cooks, marketing managers, electricians, writers and designers.

Two teams of 12 students were finally defined as the designers. Only 3 of them were from A' Class. With the escort of two teachers, they visited and played in professional escape rooms of different scenarios and one of them had an actor inside, who played three different roles. It was important to play in such a game, because theater elements would be used in the new escape room. In the next meeting they recorded all the puzzles that they could remember, discussed about their experience and they agreed that it revealed to them a meaningful experience.

Since game master's role, actor's role and rules of escape room were defined, the work-team decided that the theme should be based on the Spanish heist television series "La Casa de Papel", which includes crime and mystery, in order to satisfy players' expectations with new offerings. Online research, at that time, showed that no escape room with such subject existed in Greece. The theme was unique and helped to create the context of the room. Since role plays would exist and immersion should be enhanced, relative customs were necessary. Students made a market research and bought 8 thief uniforms with Dali's masks. The game would concern players from the age of 15 and over.

For the preparation of the act, school cooperated with the theater company "ΜΩ", which sent a volunteer actor to play theatrical games with the students. "EL GRECO", School of Fine Arts accepted to collaborate and help students create Dali paintings for the decoration of the room, in order to motivate students and keep their interests at high levels.

The next step considered the design of the room. It was decided that Computer and Network Laboratory is the best place for the designers to meet, since members of the group had for many hours relevant lessons in there and the other teachers wouldn't be bothered. Students used the trial version of Roomsketcher Software and after three phases of comments, evaluations and amendments they ended up to the final, most easy to use, design. Final photos were printed in order to be used in the future at the implementation stage.

The settings of the riddles were based on the design of the room and students used a variety of them, after taking into consideration the types of puzzles Nicholson (2015, pp. 19-20) records. Taste riddles, out-of-the-box thinking, robotics, VR and 360° videos and QR codes, team communication, observation, blue light, hidden objects, creative writing, improvisation, puzzles, physical experiments and music riddles were suggested, other simple and easy and other more difficult. Each puzzle that was created from the corresponding team, had a purpose and added a substance to the narrative of the room and was evaluated from the whole team. Based on the storyboard made at the design phase, students tried to link the riddles in a logical sequence, connect them with earlier course materials and achieve graded difficulty to them.

The scenario had two specific roles. Two of the thieves interacted with the players in an engaging way, helping them or not, instead of the game master, who gave instructions at the beginning, and got them dressed, with their eyes closed. Team thought that the engagement of the players with the actors was very important, so students defined which role they would play from the series and that the writers wrote down key-phrases for each puzzle that would be helpful to players. The game master in the entry tried to engage groups in the story, to make it real and believable to them and to create positive emotions. Each player responded, after the game, to an online inquiry in the matter of all of the above.

Marketing group in order to awake the interest of the target group, designed big posters, invitations and informative triptych and showed a presentation about the project of the escape room in an open event on May. At the same period during the informing of high school students, another presentation of the whole procedure was shown. Team believed that the scenario based on "La casa de papel" and the use of combined elements of writing, theatre and technology would make the marketing message clear, interesting and unique.

Electricians in cooperation with the designers searched on the internet, in order to find out equipment for proper illumination of the room. After that with the help of their teachers-instructors they completed the installation. By this time the design was completed.

#### **4. Home Alone 2 design**

One IT teacher, with theater and creative writing knowledge and experience as drama group coordinator and as a writer, and 12 students from A' Class, not all knowing each other since they came from different areas high schools, decided to design a new live-action game during the curriculum of CAZ. In order to cultivate their patience and senses, gain confidence in each other and bond as a team, at the beginning they played drama teamwork games. By these means the procedure became more fun and less stressful.

The working groups consisted of a photographer, two game masters and teams for game designing, marketing, writers, room digital designing and construction. The organizational committee gave room dimensions, the exact date and the hours that the room would be open to public. The timetable was created and in two months the room was ready. The team decided to create a game with middle level of difficulty, so players could be parents with primary school children or students and elders. The time for each group was 20 minutes and, between games, the game master had a 10 minute break to reposition the puzzles and rest.

Since the period that the room would be open was Christmas, students selected to watch "The Nightmare Before Christmas" and "Home Alone 2". In the first film, which is an animation, Jack Skellington - pumpkin king of Halloweentown - has become bored with the classic routine of frightening people every Christmas. In order to change that, he kidnaps Santa Claus and he brings new type of gifts, which scare and attack people. Military shoots down Jack and it's then that he realizes he must fix the mess he made. Santa finally helps him fulfill his original dream, brings snowfall to the town and Sally, his loving partner declares her everlasting love.

In the second film Kevin, a small boy instead of taking a trip to Florida with his parents, accidentally boards on the wrong plane and ends up in New York City. Using his father's credit card he stays at the Plaza Hotel, where he has to confront the staff. During his try to survive Kevin must outrun again his old enemies, while his family tries to find him.

Students preferred to work with "Home Alone 2". They watched the movie for a second time in order to write down details such as places, time, characters and objects that would help them create the puzzles, select the type of the room, game master's and players' role and other important elements of the escape room. Some of them were the following: suitcase, reverse recording, newspaper, cap, photo, Statue of Liberty, New York, coin sack, wallet, 411 room, number 3212, flowers, room service, toy store, ornaments, flowers, sweets, candies, chewing gum, TV, film, movie cases, credit card, reservation, truck sign, inflatable, shadow, curtain, notebook, paintings, bright signals, bundle of money, rope and time periods: 49:50, 55:10, 1:15:24, 34:35, 23:75, 47:15, 39:21.

Students proposed 3 types of escape rooms: a hotel room, a toy room and a trap room. Their final choice was the first one, since it was easier to be decorated. The writers came up with the plot and the roles: "Kevin locked the hotel's annoying staff in the room he booked on his father's name. They came in, in order to arrest him and prove that he was lying and that he was a little swindler. Will they be able to find the key and escape?" An escape room with a master game in the role of chief hotelier and the players in the role of hotel staff.

The final digital design of the room was depicted with the the trial version of Roomsketcher Software. Before this a draft was outlined on paper and the team evaluated and corrected the correct and most useful position of the acquired objects. The settings of the riddles were based on the digital representation and students used a variety of them, after taking into consideration the equipment the school already had from the first escape room. For the second project (Home Alone 2 Escape Room) there wasn't any financial support, so it was very important to make good use of the existing gadgets, tools and furniture. Out-of-the-box thinking, team communication, observation, blue light, hidden objects, lockers, combination of information, noticing something "obvious" in the room, searching for objects, pattern identification in images (Nicholson, 2015, pp. 19-20) were used as riddles, other simple and easy and other more difficult.

Students connected each puzzle in sequence. This meant that each puzzle was conjoined with the previous one. According to Nicholson (2015) this type of puzzle organization fits best for small rooms. A storyline was created along with the placement of the puzzles to help them during this procedure. Each puzzle had a

purpose and added a substance to the narrative of the room and was evaluated from the whole team. The initial testing of a draft room took place in a classroom.

It was very important for the success of the game and its uniqueness, students to create puzzles that weren't similar to previous escape room. This was a huge challenge both for them and their teacher. It meant that previous equipment should be used with different kind of riddle. Imagination, cooperation and out-of-the box thinking helped to win this difficult situation. A book locker that was at first used to hide the final door key, now it contained a battery for a blue light. Another example is that the first time the blue light revealed a pattern for a cell phone on the surface of a wall, now it revealed the 4-digit code of a lock on decorative posters. Students finally decided that the exit key should be on the game master's possession. They agreed that this was a very good and unexpected challenge for the players. This puzzle provoked the student-actor to think and give funny clues to the players in order to find it. In many ways this raised his self-confidence.

The integration of riddles in the mini-house followed. It was a visit to Christmas Santa Claus Yard by all of the project participants. Parents Association brought artifacts such as tablecloths, armchair, table and Christmas ornaments with a tree and helped with the decoration. Organizational committee installed school's LED light tape and equipped the room with the basic entrance locker.

The marketing group cooperated with the Guardians Association and designed an A3 poster in Adobe Illustrator. Photoshop helped them cut out Kelvin's face to integrate it on the center of the poster. Students created a movie spot with their photos during the puzzle installation of the real room in Pinnacle Studio. This was a video made for promoting and commemorative reasons. A receipt template was processed in Illustrator to become perforated for a puzzle. Team agreed that the scenario based on "Home Alone 2", the use of combined elements of writing, theatre and technology and the previous success of "La Casa de Papel" escape room would make the marketing message clear, interesting, valuable and unique.

## 5. Conclusions

Researchers emphasize that it's very important to use instructional strategies and theories, so to design educational games and to promote game-based learning (Kiili, 2005; Van Staaldunin & de Freitas, 2011; Khine, 2011). A meaningful experience is a positive and unforgettable emotional experience which can lead to a personal change (Tarssanen & Kylanen, 2009). In order to create an engaging experience both for students and players, escape room design principles (Nicholson, 2015; Wiemker, Elumir & Clare, 2015) and Experience Pyramid Model (Heikkinen & Shumeyko, 2016) were taken into consideration. Technology, theater and creative writing elements were used with privilege or newly acquired knowledge simultaneously with key elements for designing and production of games and multimedia applications (Iuppa & Borst, 2012; Papakonstantinou, 2004).

Table 1 summarizes the parts of the workflow that took place in "La Casa de Papel" escape room and Table 2 in "Home Alone 2".

**Table 1:** Summary of the parts of the procedure

Number	Part
1	The idea – Brainstorming – Working groups
2	Market research
3	Timetable – Budget
4	Pre-evaluation (online survey about students' opinions)
5	Space study and room selection – room design
6	Visit to escape room – Riddle recording
7	Theme selection – Artifacts from scenes of the serial
8	Scenario – New riddle recording
9	Theatrical games – Painting – Cooking – Experiments
10	Robotics – Programming – 360° Video capture, editing
11	Equipment – Decoration –Electrical installation
16	Storyboard – Riddle connection
17	Roles and Game master – Script
18	Implementation – Integration of riddles in escape room
19	Testing – Post-Evaluations
20	Marketing

**Table 2:** Basic parts of the procedure during escape room for Christmas

Number	Part
	The idea, Drama games, teamwork games, Working groups
	Timetable
	Space elements, target group, time for each group, time for breaks
	Theme and movie selection
	1 <sup>st</sup> view of the film to remember or inform about the story and the characters
	2 <sup>nd</sup> view of the film, recording ideas for puzzles
	Puzzle selection, according time, space, equipment
	Learning software needed (illustrator, roomsketcher, word, pinnacle studio, photoshop)
	Puzzle arrangement
	Testing puzzles in the classroom
	Implementation – Integration of riddles in escape room
	Equipment of the Christmas room
	Roles and Game master – Script
	Testing
	Marketing
	Post-Evaluations

The comparison between the two projects reveals interesting information. The design of the 1<sup>st</sup> escape room (La Casa de Papel) lasted longer. This was something expected, since the project was experimental and not necessary to be completed, none of the participants had a previous knowledge, thorough research, learning, modification and transmission of knowledge and purchase of new material took place. A large number of students from different classes cooperated with teachers from different specialties combining STEM tools and were challenged from Art professionals. The designing group also visited a real Escape Room organization so to play and understand the rules of the game and record as many riddles as possible. The equipment was funded from NOESIS, so there was a wide range of options for it.

The project gave the opportunity to the teachers to use it both as a learning environment and as an opportunity for professional rehabilitation. Tutoring was an interesting phase that united students and made the lessons enjoyable. Many technology puzzles were created and the final room was evaluated by 4 educators of different specialties and no mistakes were found. One student and one trainer, the leader author, took over as game masters-actors in the game that had the limit of 1 hour. A break of 30 minutes was important between the games.

“La Casa de Papel” escape room accounted students that aborted after the design phase. Although this period showed learners’ full engagement to the project, at the implementation phase many of them resigned from it, mostly because of their examinations and their need to find a job.

The 2<sup>nd</sup> escape room (Home Alone 2) was based on the framework created during “La Casa de Papel” project. It accounted a smaller number of participants, only from A’ Class, one IT teacher as coordinator that worked with them during Computer’s Science and CAZ Lessons. There were many restrictions during the design of this project. It was an important cooperation that needed school to contribute to the development of the municipality, offering new ideas and an innovative game to a volunteer program. It had a 2 months limit and specific, Christmas theme. There was no funding and only the old equipment or movables from the Guardians Association could be used.

Before the design, students played “La Casa de Papel” escape room, so they already got familiar with the general rules of the game. Since there were no exams during Christmas period and students belonged in A’ Class none of them aborted. There was no pre-evaluation phase or market research, since students of CAZ lesson participated from the beginning of the lessons. It’s important to highlight that, after their own experience as players in the previous escape room, they proposed to create a new one. The opportunity came after a while.

Two students and no teacher were prepared to take over as game master-actor, each of them alone with the players. This meant that they should be always on alert. “Home Alone 2” game was used to provoke their creativity and as an opportunity for professional rehabilitation. The Trade association thereafter asked the

game masters to cooperate with them, during another period. The game was transferred to another yard of the municipality and this time students were paid for their contribution.

The Christmas escape room was evaluated by students of High School and they found one mistake. Since no one would be inside the room to help the students-actors and the equipment is very sensitive the team decided to hide into book lockers and drawers replaceable objects, for example the battery of a light. This gave students flexibility, independence and self-confidence.

Two unique escape rooms were conducted in a Vocational School combining many different STEAM elements. During debriefings, the comments were positive and encouraging:

- all of the players had a positive opinion about the game and provoke students to create a new game
- some of them suggested new themes for the next year,
- players congratulated the teams because they created something original to the town,
- a primary school principal proposed to cooperate in order to transform their library into an escape room

The lead author of this paper not only was the coordinator of the action plan, but also was the main participant of the projects. Her observations during the design face are the following:

- VR Headsets was a strong motivation for tutoring others. They provoke them to extensive research and great use of their imagination.
- Learners during tutoring expressed prior interest in mobile programming and used their smart phone as QR reader, for 360o video capturing and editing with enthusiasm.
- Students found Edison robot programming very easy and had many ideas about their use in the escape room. Their final use as a puzzle helped players and students to think out-of-the-box.
- It's easier to create such a game with a small number of students.
- The 2<sup>nd</sup> escape room was easily created based on the framework of the 1<sup>st</sup> one.
- The use of movies helps find plot and artifacts to use as puzzles.
- Escape room is an extremely useful and successful tool to be used in education.
- STEAM elements create unique games and provoke imagination and improvisation during lessons.
- An online survey proved that time and moving distance is an important factor, that influences both students' and teachers' participation.

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