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Original Paper

Fostering Engagement in Science with Escape Rooms

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Abstract

This paper examines the implementation of escape rooms as an innovative instructional strategy in the science classroom to foster increased student motivation and engagement. By applying escape room concepts within the science curriculum, the aim is to create an engaging and dynamic learning environment that encourages active participation and critical thinking among students. The study involved 68 students from a year 10 (14-15 years old) group based on the British based IGCSE science curriculum. The immersive nature of escape rooms, coupled with the integration of scientific concepts and problem-solving tasks, provided students with a hands-on and collaborative approach to learning, promoting deeper understanding and knowledge retention. Additionally, this article discusses the potential challenges faced during the implementation of escape rooms and offers practical strategies for educators to overcome these obstacles. Overall, this research supports the use of escape rooms as a viable and engaging instructional tool in the science classroom, offering educators an innovative approach to foster student motivation, enhance learning outcomes, and cultivate a lifelong passion for scientific exploration. Further research is encouraged to explore the long-term effects of escape room implementation and its potential application in other academic disciplines.

Keywords

escape rooms, active learning, collaborative work, challenge based learning, context based learning

1. Introduction

Escape rooms are a type of live-action social game in which individuals work collaboratively to solve a series of puzzles in order to escape from a locked room (Rouse, 2017). In education, they have been used to promote learning and soft-skills by relating the puzzles to specific content. Students seem to enjoy the activity based on the game nature, intellectual challenge and the fact that they are working with others (Peleg, Malka, Katchevich, Moria-Shipony, & Blonder, 2019).

While planning the activities and challenges for the escape room, it was found that there are very few resources or guidance for educators in designing escape rooms and other game based education resources. This may lead to hesitation from teachers to design and develop such resources (Cardinot et al., n.d.,).

The main objective of an educational escape room is to relate real life experiences with the science curriculum, while motivating students and working on critical thinking and collaborative problem solving. As challenges are designed on a cooperative basis where a specific objective is set, active learning is promoted through social interaction. It is important, however, to connect these learning activities in such a way that learners are inspired to learn more by developing intrinsic motivation and at the same time memorable learning experiences are created (Nicholson, 2018).

The escape room activity was part of an enrichment week at school as a way to increase students 'motivation and improve attendance records at the end of the school year, since sciences are usually perceived as difficult to learn and sometimes boring (Dietrich, 2018).

Although there is a great deal of research conducted into how the use of escape rooms provides a positive learning environment for students, there is a scarcity of practical resources for educators (in particular STEM educators) in designing effective escape room activities. On account of this, we believe that this paper will provide a unique insight into the challenges and opportunities available to STEM teachers to create engaging lessons using escape rooms as a theme.

2. Method

The following aspects were taken into account for the escape room design, as suggested by Mitgusch and Robinson (2023):

purpose

- scope
- players
- mechanics
- content
- context
- style
- story

The setting of the escape room was based on a zombie apocalypse scenario, where students were required to solve the different challenges in order to "get" a vaccine through inputting a code based on periodic table elements. Each challenge could be solved independently, leading to a specific element (see Table 1 for challenge description). Once students have cracked all of them, answers were sent via a Google Form. The following chart briefly describes the challenges that were either created by the science teachers or adapted from The Royal Society of Chemistry educational resources (Allan, 2020).

A total of 68 students aged 14-15 years old participating in the escape room belong to year 10 following the British curriculum. From these students, 66% were female, 28.3% were male and 5.7%

preferred not to mention their gender. They all take part in either coordinated science or triple science. Coordinated Science and Triple Science content from the IGCSE syllabus was used as a reference for the design. The described activity was part of an enrichment week toward the end of the academic year, where students were off time table and had up to two hours to complete the challenge. The cohort usually has 6, 1 hour lessons of science each week (two lessons of biology, chemistry and physics).

The materials list and instructions for each challenge can be found in the associated content section.

Students were randomly divided into even teams of four based on the house system and year group. Students were also mixed as evenly as possible by gender and ability to ensure the groups worked as effectively as possible (Gillies, 2002). By classifying them into their houses, students were awarded with points at the end of the challenge based on their performance.

Two likert-scale surveys were conducted at the end of the experience through a Google form to assess the use of previous knowledge to solve the puzzles, students' attitudes to science, and the skills being reinforced and the connection to real-life contexts. The first survey was conducted immediately after the escape room activity had concluded, asking questions about what skills and competencies the students had used. The second survey was answered by the students two days after the activity, and asked students to reflect on their level of teamwork and resilience during the activity. Several teachers were involved in supervising the escape room activity, and they were also asked to write a brief summary about the behaviors they observed in the students, with a particular focus on resilience and teamwork. From the 68 students that participated in the escape room, 53 students completed the first survey, and 31 students completed the second survey two days later. It is worth noting that 52.8% of the participants joined the school before year 1, in contrast with the 22.6% that joined this school year.

Table 1. Challenge Description

Challenge	Description
Thermowire	Thermowire is used to represent the symbol of an element.
Chemical Changes	Hidden number code is written below the petri dish which are revealed with four different chemical reactions.
Colour Filters	Pattern that has an element hidden. Students build a filter to decipher the element.
Refraction Patterns	Students are given the angle of incidence, and need to use a ray box to shine a ray of light at that angle, and determine the angle of refraction. The angle of refraction is the atomic number. Students are given 4 options of what the angle can be, each varying by 5 degrees to allow for small errors in the experimental set up and measurements of angles.

Balancing Equations	Adding the coefficients leads to an element based on atomic number.
pH Experiment (neutralisation)	Students are given an unknown sample (X) and they have to find out which other substance will be useful to neutralise it. pH paper is used as a reference.
Flame tests	Students conduct a flame test so they associate the colour to a specific element.
DNA coding	Going from RNA to DNA by using complementary bases. Codons were associated to the ABC which lead to the name of a chemical element.
Final Code	Google Forms where they input the elements. Sending the correct answer leads to a secret location in school where the "vaccine" can be found.

Figure 1. Students Working on the Challenges

3. Result

3.1 Student Background

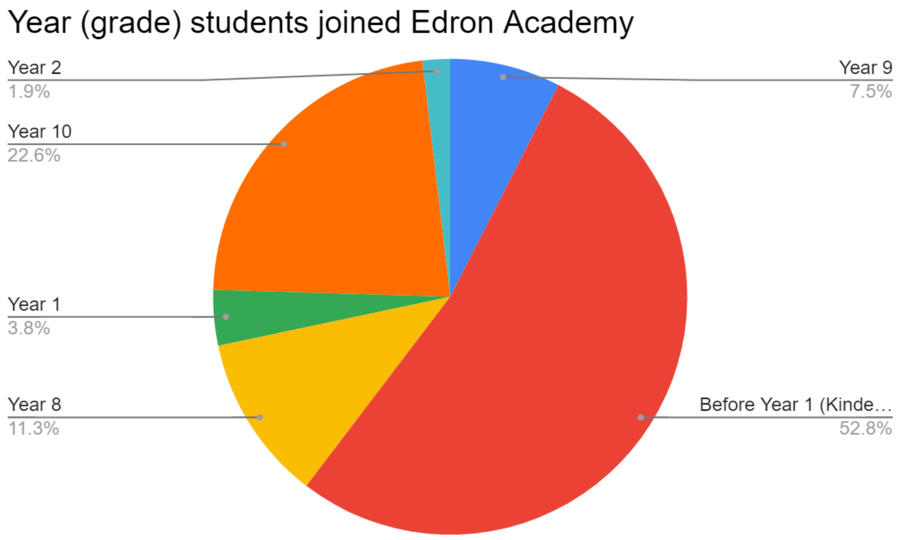

Figure 1. Academic Year Participants Joined the School Community

3.2 Initial Survey Results (Immediately after the end of the Escape Room Activity)

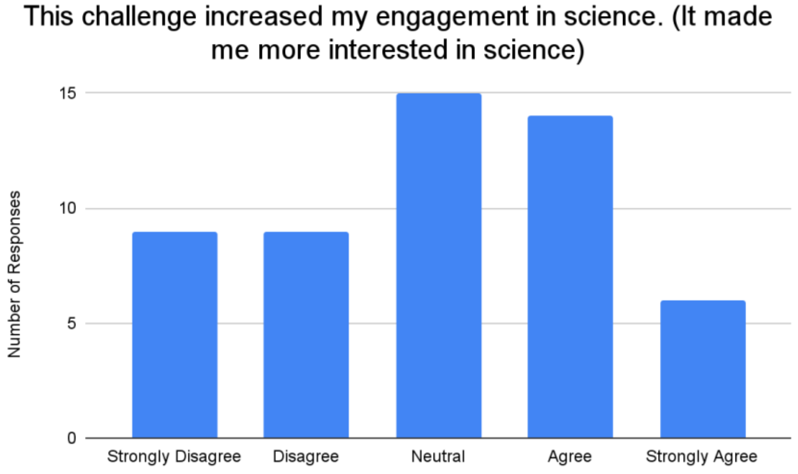

Figure 2. Engagement Levels According to the Challenge

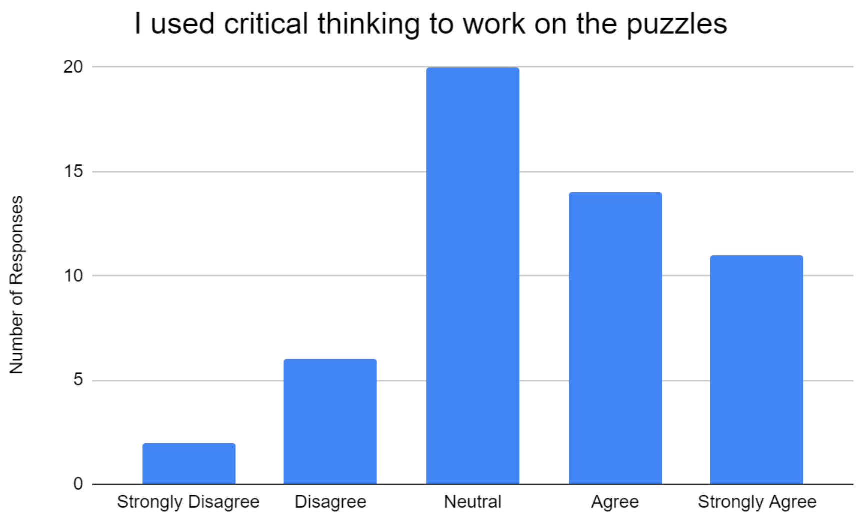

Figure 3. Students Reflection on Critical Thinking Used

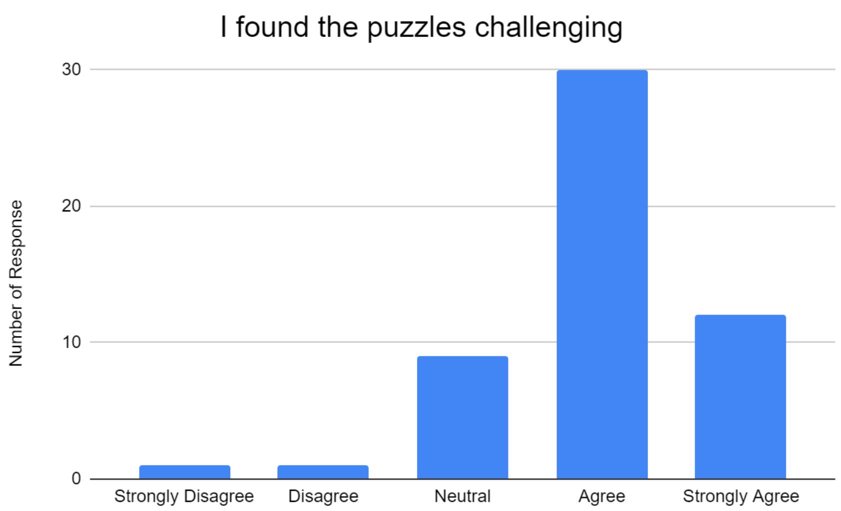

Figure 4. Level of Challenge Encountered by Students

3.3 Follow up Survey Results

After the initial survey was taken we wanted the students to reflect on their experience a few days after the activity. The follow up survey was completed by students 2 days after the activity.

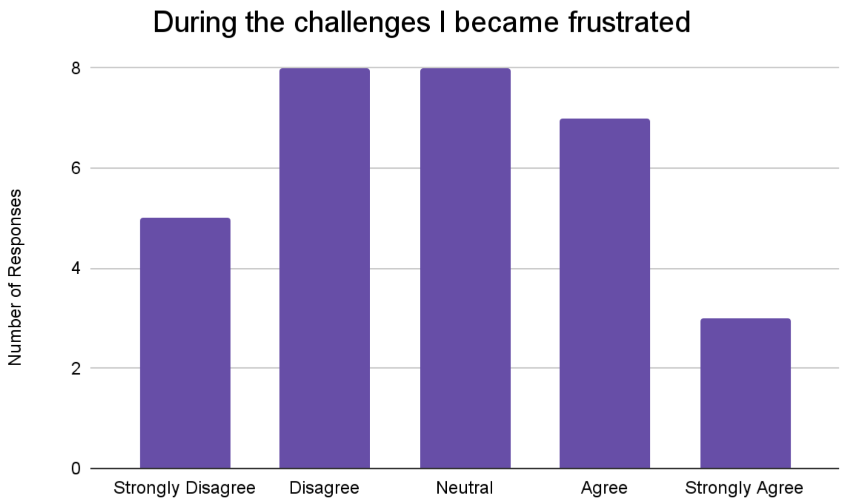

Figure 5. Frustration Levels of Students

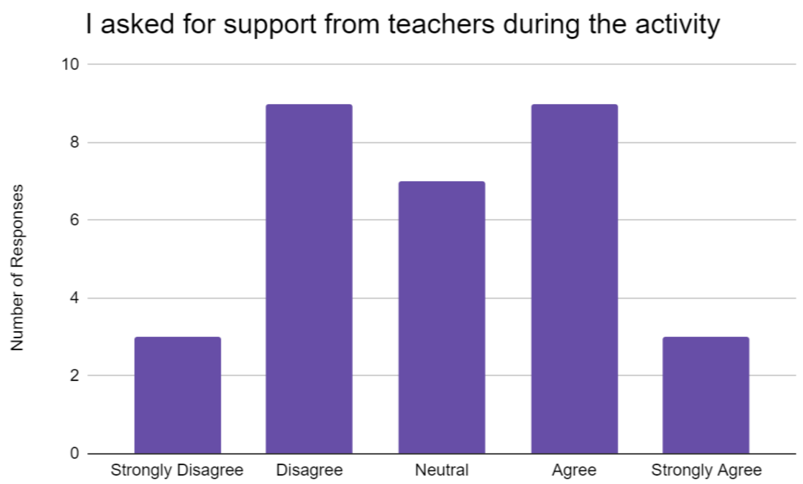

Figure 6. Amount of Help Students Asked for

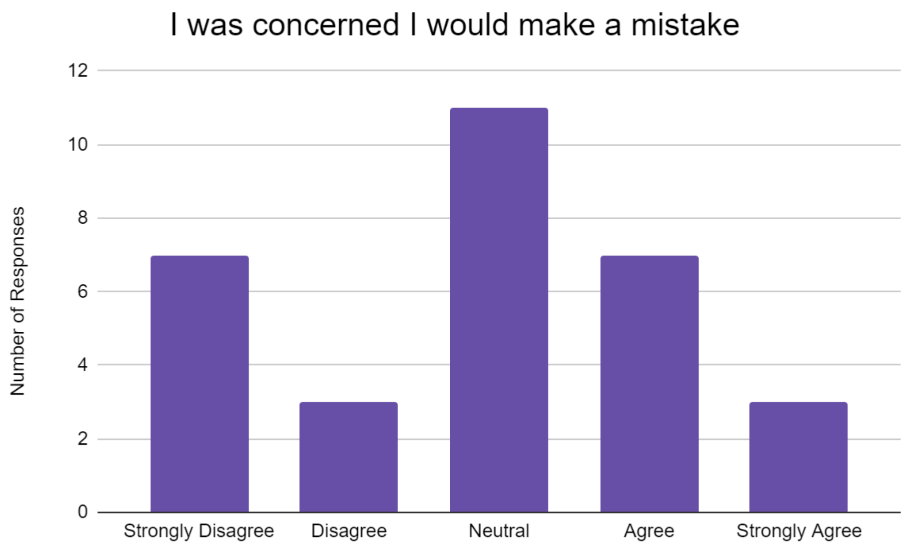

Figure 7. Fear of Making Mistakes by Students

4. Discussion

The level of engagement (Figure 2) is influenced by the narrative and the immersion of the escape room. Having a consistent apocalypse theme throughout the challenges would have definitely increased students' perceptions and interests towards science. Since all of the challenges were related to chemical elements, at some point, the narrative was lost which made students less attracted to solving the puzzles. By gamifying the experience, students become more engaged in the science topics and at the same time curiosity is stimulated. The survey shows that 38% of our students felt that the experience increased their engagement with science (Figure 2). Vörös and Sárközi (2017) have found that after participating in the escape rooms, students retained the information that had specifically helped them solve the puzzles.

When surveyed, 31% of students recognised the importance of critical thinking as a way to approach the challenges (Figure 3). At the same time, students found the puzzles challenging (Figure 4). Although the graph (Figure 5) shows that only 32.3% of the students reported feeling frustrated while solving the challenges, 58% asked teachers for help (Figure 6). What is interesting to note from both the student surveys and the teacher surveys is that the students did not believe they gave up when encountering challenges. In time, the teachers did notice this behavior in a fair number of students which is actually not reflected on Figure 5. This means that students did not perceive their level of frustration and did not recognise the fact that they were asking for help as they moved along the different puzzles. The reverse of this is that the students appear to be fairly neutral in their response to questions discussing collaboration and teamwork, but the teachers did notice their groups on the whole working together as a team and collaborating (see associated for figures). Research shows that escape rooms have impacted students positively on content knowledge and collaborative skills (Bartlett &

Anderson, 2019).

It is hypothesized that students were biased when answering the survey by choosing responses that they felt the teacher's wanted them to select. For example, a high proportion responded that they agreed or strongly agreed that they used teamwork. However, that was an area that the majority of teachers noted the students struggled with. A way in the future to avoid any biases would be to employ a question wording variation method in the student surveys, where students would answer several similar questions but worded slightly differently in an attempt to remove bias. The disadvantage of this is it would make the survey longer and could lead to survey fatigue or response acquiescence in the students. This could be avoided by making the survey more focused, or stagger the survey in stages. Another suggestion would be to use Kirkpatrick's model, which proposes four levels of evaluation: reaction, learning, behavior and results. This model can be adapted for academic contexts in such a way that the escape room's specific learning environment is assessed (Aljawharah & Callinan, 2021).

It is also important to note that this activity was the first escape room activity that the students have encountered in school, and quite probably the first ever escape room they have participated in general. This may have led students to struggling with knowing how to start to solve these types of problems. One solution to this challenge in the future would be to design smaller challenges and have students solve them in classes throughout the academic year, to improve their exposure to these kinds of problems. Hopefully, this training the students have throughout the year would increase their autonomy and resilience during the activity. This is supported by comments in the teacher survey, where at least two teachers suggested that the students might need prior training with some of the specific challenges, in particular the neutralization and balancing equations challenges. Adding these types of small challenges routinely throughout the course of the academic year would also add some opportunities for "hinterland" type activities that build upon the "core" curricula (Boxer et al., 2021, p. 12).

One way in the future that could help improve student motivation would be to try to ensure that there is an even distribution between the sciences and the number of puzzles. When running the activity this time, there were three physics puzzles (Refraction, Filters, Thermowire), Chemistry had four puzzles (Chemical changes, balancing equations, neutralization, flame tests) and biology had just one (Codons). This could have deterred students from participating that are interested or have a better ability in a discipline that was under-represented (Boxer, 2021, p. 340).

The school has a big emphasis on the arts, in particular art, drama and music. One way to improve engagement would be to include this faculty (both students and staff) in the production of the escape room. e.g., students could compose music to set the tone, videos to introduce the activity could be filmed, and sets could be designed by the art department. This would not only add context to the tasks, but also encourage collaboration between the art and science faculties. It is important to highlight that if this was implemented the challenges themselves would have to have a more direct link to the overall theme of the escape room.

While this activity was conducted in person and used physical resources, one solution to overcome the possible hesitancy from some educators to develop escape rooms would be to use a virtual option. This has been implemented during the COVID-19 pandemic during remote learning as a way to help encourage students to work collaboratively (Cossette, 2020).

5. Conclusion

In order for escape rooms to have a significant impact in students' learning, there has to be a relevant connection between the overall narrative and the design of the challenges. By ensuring this, the opportunity for engagement by the students greatly increases.

To remove frustration and encourage students to persevere through difficult challenges, it is essential that students are previously exposed to the mechanics of an escape room, this can be achieved through practicing with smaller challenges in class.

Escape rooms are a viable option to promote critical thinking and collaboration among students in a way in which they become active and autonomous in the learning process while making connections between content and real-life situations.

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Note(s)

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