**Abstract**

Background

Escape rooms are live-action team based games, where players must work together to find clues and solve puzzles in order to unlock doors or objects. While these are primarily designed for entertainment purposes, they have demonstrated value for team building and interpersonal skills development.

Methods and materials

An educational escape-box game was devised based on introductory medical statistics. It was designed to work within standard teaching rooms to reduce impact on resources and logistics. This study aimed to identify impact of the escape box activity on student understanding of statistical methods. An online survey gathered student feedback via Likert and open questions.

Results

The survey received 18 responses. Students enjoyed the activity and felt it had helped with interpersonal skills development. There was also some reported gain in critical thinking skills and an increase in student engagement and satisfaction.

Conclusion

The escape box format was well-received by students as a revision tool. Students found the format to be enjoyable, challenging and useful. The flexible and portable nature of the activity makes the teaching resource viable for large groups of students without the need for dedicated facilities.

**Escape Statistics: Evaluation of a team problem based learning innovation**

**Introduction**

Escape rooms are live-action team based games, where players must work together to find clues and solve puzzles in order to unlock doors or objects. Generally these games adopt a gripping storyline that challenges the team to escape a room before a set period of time runs out. Worldwide, 71% of teams who play escape rooms are mixed genders (Nicholson 2015), demonstrating the balanced draw of this format. Escape room activities are gradually being adopted in higher education within programming (Lopez-Pernas 2019), surgery (Kinio 2019) and nursing (Morrell 2019). These initial studies all demonstrated high levels of student satisfaction and engagement with a number of students expressing a preference over traditional learning activities. The literature also highlights how game-based learning readily improves ‘soft skills’ such as communication, leadership and teamwork (Zhang 2018) in undergraduate students, even when playing off-the-shelf entertainment titles such as ‘Call of Duty’ (Barr 2017).

Effective team working (Boak 2016) and problem solving skills (Albanese 2014) are vital attributes of allied health professionals. Traditional teaching methods on allied health pre-registration training routes are increasingly embedding team-based activities and problem-based learning (PBL) into the curriculum. (Kong 2014)

Aside from the soft skills potentially gained through Escape Rooms such as communication, leadership and group working, this project aimed to use the activity to deliver a statistics revision session. This pilot study was designed to integrate statistical learning into the session. Knowledge of statistical methods and tools is core learning for trainee health professionals, yet student feedback suggests that students struggle to understand and engage with this topic. Although most published studies thus far concern practical skills development, (Lopez-Pernas 2019, Kinio 2019, Morrell 2019 it was hypothesised that using an Escape Room activity as a teaching intervention would increase student satisfaction, engagement and understanding of this theoretical material. The research question for this study, accordingly, was “What impact does an escape room activity make on student understanding of statistical methods?”

The game itself was designed with mobility and flexibility in mind to save space and ensure the game is logistically deployable in a classroom format. Rather than a room to escape from, the students had to break into a large box, and then complete a variety of puzzles to open a locked safe. Once the outer box was opened, the game split easily into two streams to encourage students to multi-task as a group. The game and number of puzzles were designed for five players per box which allowed for multiple teams to play at the same time, adding a sense of competition. Each stage of the game required the students to solve statics based puzzles in order to obtain a number to unlock padlocks or solve a riddle to unlock a word lock or cryptex. For example, a digital code required to open the outer box was determined by calculating the mean, median and mode of sets of numbers. The content included summary statistics in relation to a distribution curve, the types and uses of inferential statistics and simple linear regression. An overall puzzle (not statistics related) was included, with pieces spread out between all locked objects. This meta-puzzle contained the final clue to open the electronic safe and complete the game.

As the revision session was designed for most students to complete, fixed prompts/hints/overrides were provided to the students at specific points in the game, mainly for the non-statistics tasks. The authors, who had taught the students undertaking the experience, provided guidance with the statistics based problems to aid learning.

Escape room experiences typically have a strong theme or story with an element of danger and the scenario given here was that the students upon entering the room, had been poisoned by “Professor Schrodinger” using a slow acting substance that caused death after 45 minutes. Professor Schrodinger had locked the chocolate-based antidote inside the safe and devised a series of puzzles based on his statistics class teaching.

Evaluation of the session aimed to identify any potential advantages associated with an educational escape box activity. The project was planned as a pilot capable of identifying any learning value to the intervention prior to possible wider uptake across the School and more in-depth research concerning optimum deployment.

**Methods**

**Subjects**

Participants were invited by email from three separate undergraduate health science programmes. This comprised second year orthoptic students, where the revision session was mandatory in their timetable and a mix of year one and two students from the radiotherapy and medical imaging programmes in the same school, for whom this was optional revision. Together this comprised a pool of around 90 potential participants. Ethical approval was granted by the University Human Research Ethics Committee and informed consent was gained prior to data collection via a gatekeeper opening question on the electronic survey.

**Intervention**

Subjects were invited in March 2019 to a designated teaching room with the escape boxes located on tables around the room, each with space around in which the group could work. Paper and pens were provided. Following a short briefing about the scenario the timer was started and groups were tasked with solving the puzzles and opening the boxes as described in the introduction section. Facilitators were on hand to provide tips if required.

**Data Collection: Survey**

Following completion of the experience, the students were debriefed with an explanation of how to solve any incomplete puzzles, and any arising statistics queries. They were then invited to participate in a voluntary and anonymous survey via an online questionnaire (using SurveyMonkey). “Question One” of this questionnaire comprised a standard consent question which prohibited progress unless informed consent was provided. The survey used a series of 11-point scale questions ranging from 0 (not at all) to 10 (completely) to gather ratings from students concerning the learning and enjoyment experience of the session. These questions can be seen in Table 1. Additional short answer open questions sought participant feedback concerning how they felt the intervention had impacted on their learning and any additional thoughts regarding the experience.

**Data Analysis**

Responses to the scaled questions were combined to determine the median and interquartile ranges. Open question responses were transcribed and randomised to prevent linkage with other questions. A traditional grounded theory (Glaser, 1978) approach was used in the absence of any existing theory relating to analysis of this intervention. Analysis involved multiple steps of data filtering and categorisation of the textual responses, conducted by two independent coders following a three-step thematic analysis approach (Giorgi 2000) to assign categories, check saturation and develop theoretical coding. The coders independently familiarised themselves with the data by reading through the answers provided. Initial open coding assigned labels to phrases within the data before recursive iterations of coding refined the labels to identify the emerging themes. Independently generated themes were compared between the coders and final themes were agreed through discussion.

**Results**

The session ran on three separate occasions, with a maximum of 20 students at a time. A total of 34 students played the game (28 orthoptic students and 6 medical radiation students). The survey was completed by 18 students, who had a mean age of 20 (SD=1.4) years. There was only one male student and four of the students had previously played an escape room game.

**Survey “rating” questions**

Students did not initially feel confident as a group of their statistical knowledge, but they felt that the game helped them to learn something about statistics and increased their confidence in their own statistical abilities. A Wilcoxon Signed Ranks test showed a highly significant increase in confidence following the experience (p<0.001).

**Survey “open” questions**

Themes emerging from the data can be seen in Table 2 with the majority of comments relating to the high levels of enjoyment gained from the escape box format. Participants reported high levels of fun and engagement; this linked well to the strong theme of a challenge. Interpersonal skills development was also a strong theme with many comments relating to the gain in team-working skills. Top of the list here was teamworking and it was clear that participants felt that the escape box required them to work collaboratively, better preparing them for clinical practice. It was also clear to see that participants felt that the intervention had improved their learning by requiring them to apply their understanding of statistical methods to a challenging practical scenario.

**Discussion**

**Enjoyment**

Student satisfaction with teaching as reported in the National Student Survey (NSS) is a major contributor to HEI performance rating within the Teaching Excellence Framework (TEF). There is, therefore, great interest in developing highly engaging teaching activities. It is clear from student feedback that the escape box format provided them with a unique and highly enjoyable learning experience which reinforced the observed high levels of engagement during the session. This aligns well with published findings related to traditional escape rooms (Lopez-Pernas 2019, Kinio 2019, Morrell 2019

Comments emphasised how different the format was to typical revision sessions with high levels of enjoyment, compared to “sitting in a lecture”. They also highlighted how the variety of puzzles maintained challenge and engagement. The intellectual stimulation of the puzzles themselves included hidden compartments and anagrams; these pushed the students to not only apply their knowledge but also their critical thinking skills. The variety of difficult puzzles simultaneously provided a challenge and the most enjoyable aspects of the session.

“It was a “great way to learn and get thinking”

Students also appreciated the facilitation of the session, with hints given appreciated and the feeling of a bond with the lecturer. The experience was highly recommended to other students and comments suggested wider use of the format be employed.

**Impact on skills development**

Interestingly, although the aim of the escape box was to provide subject-specific teaching, most of the comments relating to student perceived learning related to interpersonal skills development. These skills are cited as vital preparation for clinical practice. (Lamb 2012) There was a strong theme concerning teamwork and communication skills and it was interesting to note that this specifically included reference to working with peers that they had not worked with before and increased confidence in communicating in new relationships. With team working forming a vital aspect of allied health professional working, (Gary 2019, Paradis 2017) the project strongly suggests that interventions such as this should be introduced into clinical preparation sessions ahead of placement experience.

**Impact on learning**

It was clear that the escape box activity had been useful to participants with comments identifying an increase in understanding of statistical tests in terms of linking the names, purposes and how they are used. It was clear that, for some students, this had been a useful revision session which had helped to consolidate their knowledge and provided confidence in their abilities. The activity made an excellent revision aid ahead of assessments and future implementation will embed this into the existing formal revision support provision. This is a new application of escape room learning methods which have mostly centred on teamworking and practical skills development as opposed to theoretical learning.

**Future development**

The participants had a number of suggestions as to what other topics could be integrated into an escape room, but a number recognised the challenges of making this fit. Most suggestions were specific subject specific e.g. anatomy, physics and pharmacology, however some mentioned team working as part of inter-professional learning. A recent paper (Kutzin 2019) has highlighted the value of a simulation-centre based Escape Room for interprofessional learning and it would be interesting to investigate the comparative value of this more portable and less resource-intensive format. Conventional escape rooms are logistically challenging to setup and have a limited throughput, whereas the escape box presented here can accommodate multiple small groups in the same room with ease. It would also be interesting to determine the value of an escape room activity as a direct problem-based teaching method, challenging participants to locate resources and determine answers in small groups. Future research could compare outcomes from both formats.

**Conclusion**

An educational escape box game was devised that can be utilised within standard teaching rooms in order to facilitate group problem-based learning with minimal impact on resources and logistics. Students found the format to be enjoyable, challenging and useful, while the flexible nature of the activity makes the teaching resource viable for large groups of students without the need for dedicated facilities or expensive room adaptation. Future study should seek to identify how effective escape-box learning is compared to traditional didactic methods.

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