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Design, implementation, and student feedback on a numerical-themed escape room for a data analytics subject

Iris Lim
Centre for Urology Research, Faculty of Health Sciences and Medicine, Bond University, Gold Coast, Australia, and

Adrian Gepp
Centre for Data Analytics, Bond Business School, Bond University, Gold Coast, Australia

Abstract

Purpose – The importance of essential skills like critical thinking, effective communication and collaboration can be overlooked in content-heavy curriculums like an actuarial science degree. Educational escape rooms provide an opportunity for a group of learners to work together and solve puzzles and tasks to harness these skills. The present manuscript aims to outline the design and implementation of a physical, numerical-themed escape room tailored for actuarial science students to promote active learning and engagement and assesses student perceptions of the escape room in terms of skills development and enjoyment.

Design/methodology/approach – The escape room was offered as a team-building activity to students undertaking the subject prior to completing a group assignment. Following the game, the participants were invited to fill a printed survey questionnaire providing feedback in relation to two main aspects: skills development and enjoyment. Out of the 125 students who completed the activity, 116 students completed the post-game survey. Majority of participants agreed that the activity facilitated critical and creative thinking and problem-solving skills. Additionally, students reported with a strong consensus that the activity promoted teamwork and communication in their groups.

Findings – The present findings suggest escape rooms can in a brief period, encourage development of these crucial skills in actuarial science students. It allowed the learners the opportunity and flexibility to construct their own knowledge and actively engage in the process.

Originality/value – To the best of the authors' knowledge, this study is the first to explore the use of an educational escape room in an actuarial science program, a field traditionally dominated by theoretical and quantitative assessments. By integrating game-based learning, this research demonstrates how escape rooms can effectively foster teamwork, problem-solving and communication – critical skills for actuarial professionals. The findings provide empirical evidence on student perceptions, contributing to the growing literature on active learning strategies in higher education. This study offers practical insights for educators seeking innovative, engaging and scalable methods to enhance soft skills development in content-heavy disciplines, bridging the gap between academic training and professional demands.

Keywords Active learning, Actuarial science, Escape room, Game-based learning, Higher education, Teamwork

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Introduction

In an era where graduates are expected to possess not only technical knowledge but also essential soft skills, higher education institutions face the challenge of integrating critical thinking, communication, and teamwork into traditionally content-heavy curricula (*Links to 21st century learning*, 2022). The five key 21st century skills (or also known as "soft skills") include: critical thinking, problem solving, creative thinking, communication and collaboration (Chen *et al.*, 2022). These transversal skills are generic and applicable to future workplaces in most, if not all, disciplines. This challenge is particularly evident in disciplines like actuarial science, where the focus remains heavily on theoretical knowledge and procedural assessment. This is primarily due to a disparity between what policies define as essential assessments within these degrees, and what is valued in the outcomes. Majority of programs like these are assessed with a focus on ensuring the learner passes procedure-oriented examinations and complete theoretical and practical assignments, rather than support students to develop critical, creative thinking and communication skills.

These soft skills (critical thinking, communication, and teamwork) are most closely related to notions like inquiry-based learning and collaboration, leading to improved decision making with respect to complex real-life problems. The value of this set of skills in a field like actuarial science is clear as it prompts the learners to search for multiple ways to approach difficult mathematical and statistical problems, select the best approach and then ultimately reach a solution that might not have been visible or straightforward to start with (Doorman *et al.*, 2019). The most recognised fields that actuaries work in are insurance, superannuation, wealth management, investments, health financing and banking (*What Does An Actuary Do?*, 2022). Universities are therefore tasked with preparing and ensuring that their students are assessed using real-world and authentic assessment to ensure they are competent and prepared for the dynamic and variable nature of their future workforce environments when they graduate.

With the rapid advancement of technology and the advent of generations Y (commonly known as Millennials, born approximately 1981–1996) and Z (born approximately 1997–2012) learners into the higher education setting, interest in and engagement with traditional delivery modes limited to passive lectures and purely educator-directed sessions are declining (Cevikbas and Kaiser, 2022). While active learning has long been recognised as an effective pedagogical approach across generations (Hurd, 2000), its importance has become even more pronounced with this generation of learners, known for their digital fluency, preference for interaction, and expectation of engaging, technology-enhanced environments. In this context, traditional delivery modes such as passive lectures are increasingly seen as insufficient for fostering the deep engagement and skill development expected in higher education.

The variety of active learning strategies continue to expand with the rising incorporation of game-based learning, gamification, and serious games into curriculum (Buckley and Doyle, 2016). The implementation of game-based elements offers opportunities for true active learning, creativity, problem solving, fun and social interaction, and can appeal to a wide range of learning styles (Ritzko, 2011). It provides learners a chance to escape the realm of theory and apply their knowledge and skills in a context outside of examinations and assignments (Mora *et al.*, 2017). These activities are strongly aligned with key educational theories: constructivism, which holds that learners construct knowledge through active experience and reflection (Young, 2007); sociocultural theory, which emphasises the role of social interaction and collaboration in learning (Wang, 2007); and behaviourism, where learning is reinforced through stimulus-response patterns and immediate feedback (Detlor *et al.*, 2012).

Some examples of non-digital and digital games that are used to implement game-based elements in classrooms include role-playing, simulations, crosswords, and puzzles. While literature suggests these are more common in disciplines like health sciences, the latter two examples have been shown to be effective to enhance motivation and learning in actuarial science students (Mayorga-Toledano and Fernández-Morales, 2019). Furthermore, the intersection of physical and digital modalities in active learning strategies is gaining attention within the realm of smart education. Hybrid experiences offer a promising approach to fostering digital fluency alongside soft skill development. Such blended designs reflect an evolving pedagogical paradigm where learners engage in immersive, tech-enabled environments that simulate real-world complexity and collaboration.

Escape rooms are known as a popular worldwide leisure activity that appeals to a wide audience range of all age groups, including adults, youth and children (Nicholson, 2015). An escape room is defined as a:

> […] live-action team-based game where players discover clues, solve puzzles, and accomplish tasks in one or more rooms in order to accomplish a specific goal (usually escaping from the room) in a limited time (Nicholson, 2015).

Although the idea of escape rooms as a pedagogical tool is novel, it has been incorporated within various levels and disciplines in the education setting with optimistic outcomes (Taraldsen *et al.*, 2022). Adopting the concepts of commercial escape rooms, educational escape rooms and escape room-inspired activities have been designed to achieve a multitude of learning objectives. Regardless of whether the activity is conducted digitally or physically, the initial evidence supports that escape rooms can be effective to increase knowledge acquisition (Christopoulos *et al.*, 2022), camaraderie and communication skills (Foltz-Ramos *et al.*, 2021; Lundholm *et al.*, 2022; Moore and Campbell, 2021), student motivation and engagement (Terrasi *et al.*, 2020), problem-solving and critical thinking skills (Lim, 2023; Nelson and Crea, 2021) across all disciplines. In recent years, a growing number of studies have explored the pedagogical value of educational escape rooms across a range of disciplines. These studies consistently report positive outcomes related to student engagement, motivation, and the development of soft skills such as communication, collaboration and critical thinking. While the majority of documented applications remain concentrated in health and medical education (Backhouse and Malik, 2019; Diemer *et al.*, 2019; Guckian *et al.*, 2020; Kinio *et al.*, 2019; Krishnan *et al.*, 2023; Reed and Ferdig, 2021), successful use cases have also emerged in computer science (Borrego *et al.*, 2017), engineering (Davis and Lee, 2019; Gordillo and Lopez-Fernandez, 2024; Ross and Hall, 2024), and mathematics (Babo *et al.*, 2023; Zapata *et al.*, 2024).

Escape rooms are played in teams and in a collaborative mode. Therefore, they are primarily associated with a socio-cultural approach to learning (Taraldsen *et al.*, 2022). Escape rooms have been shown to facilitate participants to co-operate, communicate and be critical and active in their thoughts (Nicholson, 2015). In addition to this, elements within other learning theories like constructivism and behaviourism have also been recognised within the activity (Wargo and Garcia, 2021). Participants construct knowledge based on the immediate puzzles, tasks and clues in the room and positive behaviours are enforced throughout the duration of the game to 'escape' or achieve a goal within the game. Additionally, it promotes student engagement and persistence on tasks which are critical conditions for deep learning (Aubeux *et al.*, 2020).

While a central aim of education is to support students in acquiring disciplinary knowledge, as educators, graduate attributes and employability skills like critical thinking, effective communication skills and how to be a team player are arguably some of the most

challenging skills to teach. There is a need to explore ways that we can marry curriculum content with the development of these key competencies. Because escape rooms provide an opportunity for a group of students to work together as they explore a space and solve puzzles within a limited amount of time, the skills harnessed and developed within the game by participants are parallel to these skills. While escape rooms have been widely used in medical and health sciences education (Taraldsen *et al.*, 2022), there is limited evidence of their application in disciplines like actuarial science, which traditionally focuses on quantitative skills.

The present study is an investigation where undergraduate and postgraduate students enrolled in an actuarial science subject completed an escape room within an Australian university. Feedback was obtained following the completion of the game. This paper also outlines the escape room puzzle flow and scenario created for this study. While it was themed with content from the subject, the puzzles and tasks within the game did not require knowledge of subject content to be solved and accomplished. The game was created solely to nurture teamwork, communication, and problem-solving skills. Thus, the research questions for this study were:

RQ1. How effectively can a campus-based, numerical-themed escape room be designed from the ground up to enhance essential skills among actuarial science students? and,

RQ2. What insights can be gathered from actuarial science students' perception and feedback on the escape room experience?

Methodology

This quasi-experimental mixed methods study was designed to address the research questions outlined in the Introduction, focusing on the design process of the escape room and students' perceptions of its impact on soft skill development.

Ethical approval and participants

Ethical approval was sought from and granted by the institutional Human Research Ethics Committee. The sampling was intentional, where the escape room experience was offered to students enrolled in the subject Stochastic Processes (Subject Codes: ACSC13-306/ ACSC71-306). It is generally taken by students in their third or fourth semester enrolled in the Bachelor of Actuarial Science program at an Australian private university. The subject focuses on stochastic processes that are typically used to model the dynamic behaviour of random variables indexed by time and applications to insurance, reinsurance, and insurance policy excesses, amongst others. Students formed their own groups to complete the activity, knowing that they would be working together on an assessed group project later in the semester.

Escape room development and design process

The process of designing and creating educational escape rooms varies based on the intended learning objectives. However, the fundamental concept remains consistent: constructing a scenario in which a team collaboratively tackles a series of puzzles to uncover clues, hints, and objects, while accomplishing a series of tasks that lead to the ultimate achievement of a final goal (Adams *et al.*, 2018).

The first step in the design process was to decide on the learning objectives that the activity sought to achieve. The subject itself was already packed with synchronous and

asynchronous resources for knowledge acquisition and content revision including lectures, tutorials, computer laboratory sessions, mock tests and more. Thus, the intended main objective of the escape room was for the students to undertake an enjoyable activity that could promote the development of soft skills like collaboration, communication, and critical thinking before completing their assessed group project together. Upon deciding on these objectives, the puzzles and tasks within the game were designed to only require logical and lateral thinking to complete. The puzzles and tasks within the game were developed by the designers who drew from extensive experience in participation in commercialised escape rooms. However, the escape room was embedded and themed with topics and concepts that are covered in the subject. Additionally, the element of fun and enjoyment was also carefully considered in the creation process of the room. Meanwhile, the scenario and puzzles were incorporated and themed with topics and concepts related to the data analytics subject. For example, one of the puzzles required participants to engage with the statistical software R, a key tool used throughout the subject, to input a code and run a simple code to retrieve a crucial clue. This not only added an element of realism and subject relevance to the activity, but also reinforced digital literacy by prompting students to apply a course-specific technological skill within a collaborative, problem-solving context.

Escape room scenario and puzzles

Every escape room has a quasi-real scenario as this encourages roleplay and fosters player immersion in the game (Lucardie, 2014). In this escape room, the role given to the participants is that their team of players is part of an elite cybersecurity organisation. An experienced hacker has stolen millions of dollars' worth of data from an insurance company. This cybersecurity team was placed in the 'residence of the hacker' to obtain a USB which contains a program to retrieve the stolen data. However, they only have 45 min before the 'hacker' returns. This escape room was named "Operation: Unhack". For our execution of the game, we utilised a small teaching room within the campus. Props and items that were used include common items found in homes and digital devices to mimic a hacker's working space (e.g., photo frames, wallet, fake money, books, laptop) which provide the framework for embedding the puzzles, tasks, and clues (Figure 1). Since this was a physical escape room, it was important that the props and items were realistic as they form an important part in stimulating the environment of the game scenario and ensuring that participants are immersed in the game. With a small amount of funding available, the props were purchased and re-designed to be fit for the puzzles and tasks in the room.

During the pilot stage, a group of colleagues and higher degree research students were invited to participate in the escape room game as a validation cohort to ensure that all stages of the game were optimised. These groups were invited to provide feedback on the room, particularly regarding puzzles and clues that were not logical, confusing, or too difficult. This validation process did not result in any major modifications, but ensured that the progression of the activity was robust. The finalised puzzle flow of the game can be perused in Table 1.

Escape administration

The escape room experience was offered as a team-building activity in the third and fourth week of the semester to students undertaking the subject. Participation in the activity (independent of room completion success) contributed to a small percentage of the students' group assignment mark for the subject. On the day of the escape room game, a 10-minute verbal briefing was given by the "game master" where participants were provided with the ground rules and the scenario. The ground rules provided were similar to those of traditional escape rooms. These include no climbing on furniture, no forcing locked boxes or padlocks

Figure 1. Photo of escape room setup. Items, clues, hints, and locks were scattered throughout the classroom. The workspace within the residence of a hacker was mimicked as much as possible using props, in accordance with the scenario of the game
Source: Created by authors

open, no carrying heavy objects around and establishing areas in the room that were not in play (e.g., computer and equipment for livestream system).

Following the briefing, the participants were allowed into the room, after which they have 45 min to solve the series of puzzles and ultimately obtain the USB and retrieve the "stolen data". The whole experience was observed by the "game master" from another room, using a webcam and microphone through a live stream system. A TV screen on the wall displayed the timer and it started counting down as soon as the students entered the room. Throughout the game, hints were given if the participants asked for them via this same TV screen, either in the form of text or picture. Occasionally, the 'game master' would also provide hints if the team appeared to be stuck on a puzzle for a long period of time. The game ended when the USB was obtained by the participants or when the timer expired.

Data collection and analysis

Following the "escape", the participants were invited to fill a printed survey questionnaire providing feedback on the experience and informed consent to collate this data. The questionnaire consists of socio-demographic questions and Likert-type scale statements that were developed using existing surveys already published in the literature surrounding the use of educational escape rooms (Brady and Andersen, 2021; Caldas *et al.*, 2019). Survey questions were established around the five key components of 21st century-skills dispositions: critical thinking, creative thinking, communication, teamwork, and problem-

Table 1. "Operation Unhack" escape room puzzles

No.	Puzzle	Action required	Answer/item/clue retrieved
1	Participants receive a 'hacker profile' in a folder at entry	Examine the hacker profile meticulously	Deciphered morse code open a mini-safe with the USB to retrieve stolen data
2	Playing cards scattered and hidden around the room	Collect and arrange playing cards in descending order	Spell out a name which is found on a list of names with contact numbers
3	The correct contact number from previous puzzle unlocks a diary	Locate a clue in the diary which guides players to a specific page in a textbook in the room	A number sequence is located on the correct page which unlocks another padlock
4	The previous puzzle unlocks a box with puzzle pieces, Greek letter decoder, and a UV torch	Assemble the puzzle Shine UV light on a shirt to reveal a code Solve the code using both the Greek letter decoder and the completed puzzle	The solved code provides a number sequence which opens the another safety box
5	The next unlocked box consists of a dog tag with a name and a hint card	Use the dog's name as a password Solve the puzzle on the hint card	Access a laptop in the room Obtain a number sequence to enter in 'R' program on the laptop and run the code to obtain an answer
6	The answer obtained from the previous puzzle opens a box containing a phone with an audio file and a morse code decoder	Decode morse code audio	Open a mini-safe with the deciphered morse code and obtain the USB to retrieve the stolen data

Note(s): The puzzle flow in this room is linear – participants must complete one puzzle or task before moving on to the next
Source(s): Created by authors

solving (Chen *et al.*, 2022). At the end of the questionnaire, there were three optional open-ended questions seeking general positive and negative feedback on the escape room game and what they would have done differently if they played it again. The current data was collected across three semesters with three different cohort of students between August 2022 and September 2023.

The survey responses were entered into GraphPad Prism (GraphPad®) for analysis. For the Likert-scale items, descriptive statistics including frequencies and means were calculated to summarise overall trends. Given the exploratory nature of the study and the ordinal nature of the Likert data, inferential statistical testing was not used in this phase. We conducted a basic subgroup comparison using independent t-tests between participants with prior escape room experience and those without, to explore potential perceptual differences. No statistically significant differences were found.

Open-ended responses were analysed thematically using an inductive approach. Responses were read multiple times and coded for emergent themes by two independent researchers. Themes were then clustered into overarching categories of positive experiences, areas for improvements and suggestions for future iterations. Frequencies of theme occurrence were also reported to illustrate dominant perceptions. This qualitative analysis offered deeper insight into the context behind the quantitative findings.

Results

A total of 23 game sessions were held (40 groups of 3–4 participants). Out of the 40 sessions, 37 teams completed the room and achieved the goal within the time limit, with varying amounts of time left and number of hints required. A total of 145 students took part in the escape room experience, 116 of which completed the post-game survey. Those who completed the survey had a demographic profile of 60% males, 39% females, 1% non-binary and an average age of 20.3 years (SD = 2.55) (Table 2).

Table 3 presents the results of Likert-scale type questions administered to participants upon completing the escape room. The responses are categorised into three main themes including teamwork, communication and critical thinking skills. Each theme consists of multiple items related to participants' perceptions and experiences during the escape room activity.

A significant majority of participants (58%) strongly agreed, and 42% agreed that the escape room helped establish a strong foundation of teamwork that would benefit their upcoming group assessments. Furthermore, nearly all participants (93%) indicated that they learned more about their team-mates' strengths and weaknesses during the activity, with 47% agreeing and 46% strongly agreeing. The escape room experience also enhanced participants' confidence in their team's ability to handle challenges, with 94% agreeing or strongly agreeing. Additionally, half of the respondents (50%) felt that their team dynamics improved, while another 42% agreed with this sentiment.

Participants widely perceived the escape room an effective tool for enhancing communication skills. Nearly all participants (99%) agreed that the activity required clear and effective communication. Similarly, 98% of participants felt that the escape room improved their ability to listen to and understand their peers' perspectives and acknowledged the importance of listening to all team members before making decisions, indicating heightened awareness of effective communication. Furthermore, 97% became more aware of their communication strengths and areas for improvement. However, 80% of participants also noticed areas where their team's communication could be more efficient, suggesting that the escape room served as a reflective tool for identifying communication gaps.

Participants also perceived the escape room as fostering creative and critical thinking. A majority of participants (97%) reported that the activity required them to analyse situations and synthesise information quickly. Additionally, the activity encouraged out-of-the-box

Table 2. Participant demographics

Total no. of responses	116
Gender	
• Male	70 (60.3%)
• Female	45 (38.8%)
• Non-binary	1 (0.9%)
Age group	
• 18–20 years	88 (75.9%)
• 21–30 years	24 (20.7%)
• > 31 years	4 (34.5%)
Prior escape room experience	
• Yes	41 (35.3%)
• No	75 (64.7%)

Source(s): Created by authors

Table 3. Responses to Likert-scale type questions following completion of the "Operation: Unhack" escape room

Theme	Item	Frequency (%) Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Teamwork	This activity helped establish a foundation of teamwork that will be beneficial for our group assessment	-	-	-	49 (42%)	67 (58%)
	I learned more about my teammates' strengths and weaknesses during the escape room	-	4 (3%)	4 (3%)	55 (47%)	53 (46%)
	I feel more prepared to undertake group assessments with my team after this activity	-	-	38 (33%)	38 (33%)	40 (33%)
	I believe our team dynamics improved as a result of the escape room	-	-	9 (8%)	49 (42%)	58 (50%)
	After the escape room, I am more confident about our group's ability to handle challenges in our upcoming assessment	-	-	7 (6%)	55 (47%)	54 (47%)
Communication	The activity required clear and effective communication among team members	-	-	1 (1%)	57 (49%)	58 (50%)
	The escape room enhanced my ability to listen to and understand the perspectives of my peers	-	-	1 (1%)	57 (49%)	58 (50%)
	I found it crucial to actively listen to all team members before making decisions	-	-	1 (1%)	35 (29%)	80 (69%)
	I became more aware of my communication strengths and areas for improvement during the escape room	-	1 (1%)	1 (1%)	53 (46%)	61 (51%)
	I noticed areas where our team's communication could be more efficient	-	1 (1%)	23 (20%)	70 (60%)	22 (20%)
Creative and critical thinking	The escape room required me to analyse situations and synthesise information quickly	-	3 (3%)	-	58 (50%)	55 (47%)
	The escape room prompted me to think outside the box and approach problems differently	-	-	-	36 (31%)	80 (69%)
	I felt that the escape room helped me think under pressure and make swift decisions	-	1 (1%)	-	50 (43%)	65 (56%)
	I found the challenges in the escape room tested my ability to identify relevant data and discard distractions	-	-	1 (1%)	28 (24%)	87 (75%)
	I felt the escape room promoted logical reasoning and structured thought processes	-	-	-	29 (25%)	18 (75%)

Source(s): Created by authors

thinking, with 69% strongly agreeing and 31% agreeing that they approached problems differently during the game. The pressure to think quickly and make decisions was recognised by 99% of respondents, and 75% agreed that the escape room challenged their ability to filter relevant information and discard distractions. Finally, 75% of participants felt that the activity promoted logical reasoning and structured thought processes, highlighting the educational value of the escape room in developing higher-order thinking skills.

To further explore students' perceptions of the escape room, open-ended feedback was collected, allowing participants to express their thoughts in their own words. The responses were analysed and categorised into themes, revealing both positive experiences and areas for improvement. Table 4 presents a summary of these open-ended responses, highlighting the most frequently mentioned themes. The most prominent positive feedback centred around the fun and enjoyable nature of the activity, with many participants praising the puzzles and the overall engaging experience. Additionally, the escape room was seen as a valuable team-building exercise, promoting collaboration and structured thinking. Participants also appreciated the interactive and thoughtfully crafted design of the room, as well as the opportunities it provided for creative and critical thinking. While the majority of feedback was positive, a few constructive suggestions were provided. These included requests for more specific, equation-based challenges and improvements in immersive elements, such as props or lighting, to enhance the atmosphere. Participants also reflected on lessons learned, such as enhancing communication, relying more on team-mates, and improving observation skills.

Discussion

The teaching of skills like problem solving, critical thinking and team dynamics can prove to be challenging in higher education programs that are content-heavy (Marakovits, 2022). As an innovative didactic tool, escape rooms integrate both game-based elements and active learning simultaneously (Zhang *et al.*, 2018). In the present study, we designed an on-campus physical escape room game to create opportunities for the application and exploration of critical and creative thinking, problem solving and most importantly, teamwork and communication skills within groups of students. Particularly, we developed the game for students undertaking an actuarial science degree and it was embedded in a data analytics subject within the program. Specifically, the present investigation focused on the perceptions and feedback from students following the completion of the game.

As seen with previous studies on educational escape rooms (Taraldsen *et al.*, 2022), the quantitative results from the present study indicate that the majority of participants perceived the escape room experience as enjoyable and beneficial in supporting the development of critical thinking, problem-solving, creative thinking, teamwork and communication skills in an innovative and engaging way. Regardless of profession and discipline, being able to work together and communicate within a team and to think critically are graduate attributes that are expected of students. Within the higher education setting, previous education escape rooms have mainly been employed at the higher education level in programs related to health and medical sciences (Anderson *et al.*, 2021; Aubeux *et al.*, 2020; Christopoulos *et al.*, 2022), computer science (Borrego *et al.*, 2017) and data science (Nelson and Crea, 2021). To our knowledge, this is the first data analytics themed escape room developed specifically for actuarial science students. Previous literature has suggested that actuarial science students have a demanding workload in their program (Mayorga-Toledano and Fernández-Morales, 2019). In this study, we aimed to provide the students with an activity that did not involve complicated mathematics or statistical concepts to apply as these are already heavily tested in other assessment pieces.

Table 4. Questionnaire responses to open-ended questions

Theme	Representative sample	Frequency
Positive feedback		
Fun and enjoyable	"It was very fun, very satisfying to solve, and had a wide and expansive range of tasks" "I actually really enjoyed it and I think the puzzles were great" "It was a lot more fun and interesting than I [expected]" "I enjoyed the fact that it was fun and entertaining" "It was fun but not too hard" "I thought that the clues were well thought out and really fun!"	55
Teambuilding	"It was really fun. I got to know my group members better" "[Great] team building exercise and promoted logical and structured thinking" "Medium difficulty, so we can focus more on enhancing the teamwork rather than just the content material" "It was really good to get involved with my group and gel to know them more" "It was a good way to engage with team members"	48
Interactive and Well-Created	"Very interactive and well created" "It was a fantastic escape room, really well made" "I thought that the clues were well thought out and really fun!" "It was really well done and comparable to paid experiences"	35
Critical and creative thinking	"Interactive and awarding for the ones who think outside of box" "It used critical thinking skills and also helped our team bond" "I like that it was creative in different ways, and challenged multiple different roads of thinking" "I enjoyed the critical thinking aspect of the puzzle, without a need for background knowledge" "It didn't require too much knowledge just strong critical thinking skills to get it done"	35
Negative feedback		
More specific puzzles	"More challenges that maybe involved equations" "If possible, I would suggest making problems which utilises multiple people to complete to encourage teamwork"	6
Immersive elements	"It's good enough for a on campus escape room. But some props or lighting effects would help to create immersion and make players more nervous"	1
Lessons for Future Experiences		
Communication and teamwork	"I would like to rely more on my teammates and spread out problems rather than all focusing on one" "Communicate more efficiently" "Use my teammates' strengths to complete the escape room" "Plan the first 5 min beforehand"	32
Observation	"Take a look around the whole room first" "Be more thorough, especially during the beginning and the end" "Sort evidence in a [clearer] manner" "Try to look at every piece of information give"	24
Avoid overthinking	"Not obsess over particular pieces of 'evidence' that are clearly red herrings" "Do not overthink the clues laid out"	13

Source(s): Created by authors

Interactive learning environments have been shown to enhance willingness of learners to communicate and collaborate and increase the tendency of learners to think in higher dimensions (Hwang *et al.*, 2018). Within this room, the puzzles and tasks were designed to ensure that their completion required collaboration, communication, situational awareness, time management, and higher order thinking skills such as reasoning, critical and lateral thinking. A wide variety of puzzle types were implemented in this game, to increase opportunities for every individual participant in the group to be involved and contribute to the team. The activity was intentionally embedded into the subject to promote team dynamics within each group, as they were to complete a group assignment collaboratively in the following weeks.

The quantitative feedback collected from all participants indicate that they found the room enjoyable, and the open-ended responses further support the positive perceptions of the participants. The most common theme among the positive responses was that the escape room was a fun and engaging activity that was different from their usual university activities. Incorporation of elements of fun and enjoyment are known to encourage and motivate participation in learning with enthusiasm and motivation (Lucardie, 2014). The escape room was a learning activity that reduced the usual pressure of assessments and due dates but at the same time, allowed the participants to learn and apply their problem-solving and communication skills. On the other hand, there were only a few negative responses, and there were no recurring themes to these comments. The feedback obtained from participants regarding what they would do differently in a future escape room experience with the same team offers valuable insights into key areas of improvement that they reflected on. One recurring theme revolves around the enhancement of communication and teamwork skills. Participants emphasised the significance of relying on their teammates, efficient communication, and capitalising on the unique strengths each team member brings to the table. These insights underline the fundamental role of collaboration and effective communication in successfully navigating the challenges presented by escape rooms. Another notable recommendation from participants pertains to observation skills. Many suggested taking a more comprehensive initial look around the room, being more thorough at both the beginning and end of the activity and ensuring a clear and organised approach to sorting evidence. These observations underscore the importance of situational awareness and attention to detail within the context of escape room activities. Strengthening these observational skills not only contributes to the successful completion of puzzles but also fosters a more efficient and streamlined problem-solving process. These valuable insights not only benefit participants within the scope of escape rooms but also hold broader implications for their application in various educational settings and professional contexts.

The successful development and execution of the escape room required a substantial amount of resources including time, effort and expertise. The development of the puzzles and the game was the most time intensive portion of the activity, since materials related to the subject were intentionally embedded into the game (approximately 20 h). This proved to be rewarding, as some of the recorded positive open-ended responses and verbal remarks from informal conversations with the participants alluded to how they appreciated and enjoyed that the game was related to the subject. Although the escape room was primarily a physical experience, the intentional integration of digital tools contributed to its alignment with contemporary models of smart education. Most notably, one of the critical puzzles required the use of the statistical software R, an essential program in the data analytics subject, where students had to input and run a simple code to retrieve the next clue. This interaction bridged curricular content with real-time application of a digital platform. These elements reflect the evolving nature of interactive learning spaces, where analogue activities are enhanced

through embedded technologies to create immersive, blended learning experiences. This hybrid approach reinforces both discipline-specific digital fluency and essential transferable skills, underscoring the relevance of such activities within the scope of technology-enhanced education.

In addition to time spent for development, a pilot session was also run with colleagues and higher degree research students. The escape room set-up costed approximately AUD60 worth of materials including padlocks, flashlights and props. Although the process was not without cost, once the puzzles and the scenario are designed, they can be repeatedly used in the future and can also be replicated in other institutions [1]. Because the number of participants were limited to students undertaking this specific subject, we were able to run the escape room consecutively in three days. To increase the scalability of the activity, more physical space, and facilitators to debrief participants and reset the room will be required.

While the findings of the present investigation were positive, there are limitations which can be addressed in future studies. Some limitations of our study included that the sample size is small and therefore limits our ability to generalise the findings to a broader range of learners. The current investigation focused on the feedback and perceptions of the participants on the enjoyment and usefulness of the game to develop soft skills. In the future, a more in-depth inquiry could be made to explore participants' reflection on team dynamics before and after the game. or example, whether the activity encourages the overcoming of barriers as a team, how different personalities are managed within the game, leadership, and multitasking. To strengthen the robustness of future evaluations, more comprehensive methods could be employed, including pre- and post-activity measures, expert review or vetting of participant performance, and triangulation with observational or video data. For example, involving teaching and learning experts to observe gameplay or debriefs could provide an external lens on team dynamics, communication patterns, and problem-solving strategies. Future studies could also explore the effectiveness of the escape room activity in promoting specific soft skills.

The value of escape rooms as a tool for skill development is not confined to educational contexts. Increasingly, organisations in the corporate sector are adopting escape room-style activities for onboarding, leadership development, and team-building exercises. These experiences aim to replicate real-world workplace dynamics by immersing teams in high-pressure, time-sensitive problem-solving environments that require strategic communication, delegation, and adaptability. From a psychological standpoint, escape rooms align with several well-established learning and motivational theories. Drawing on experiential learning theory (Kolb and Kolb, 2005), participants learn by doing, reflecting on actions, experimenting with solutions, and adapting behaviour. The time-limited and goal-oriented nature of the activity induces a state of flow (Boffi *et al.*, 2016), where learners are fully engaged and cognitively immersed. Additionally, the social, collaborative aspects support sociocultural learning theory (John-Steiner and Mahn, 1996), in which knowledge is constructed through shared dialogue and group problem-solving. These psychological principles underpin the efficacy of escape rooms as a learning tool across both academic and professional settings, strengthening the case for their broader adoption.

Conclusions

Despite being known mainly as a leisure activity, escape rooms have proven to be beneficial beyond just as an entertainment. They allow players to leverage employability skills such as teamwork, creative thinking, problem-solving and communication through play (López-Pernas *et al.*, 2022). The present findings suggest escape rooms can in a brief period, encourage development of these crucial skills. While this particular room was not designed

to increase students' learning outcomes related to the content of the subject, it allowed them the opportunity and flexibility to construct their own knowledge and actively engage in the process. Additionally, this activity naturally comes with an element of fun, making the experience memorable and engaging. Overall, the escape room activity designed for this study was a successful way to promote the development of soft skills and was perceived as an enjoyable and engaging experience by most participants.

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Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee. The study was approved by the Bond University Ethics Committee (Project ID: IL00036). Informed consent was sought from each participant during the survey process.

Competing interest: None to disclose.

Author contributions: All authors were involved in the study conception and design, with IL being the primary contributor. Material preparation, data collection and analysis were performed by IL and AG. The first draft of the manuscript was written by IL and AG provided feedback. All authors read and approved the final manuscript.

Data Availability Statement: The data sets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Availability of Supporting Data: Not applicable.

Note

1. If there is interest in implementing this escape room in other institutions, please do not hesitate to contact the corresponding author for a full digital package with guidelines on how to set up the game. This package includes the briefing and scenario script, list of props required, reset checklist, map of room layout, and printable files for all clues and puzzles. The game is reproducible anywhere, as long as props can be obtained and there is a physical room that can be used.

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Corresponding author
Iris Lim can be contacted at: ilim@bond.edu.au