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Original Article

Examining the Impact of Escape Room-Based Assessment on Nursing Student's Self-Efficacy Perception

Mohammad Hossein Abdollahi Nodehi[1], Mahin Naderi Far[2*], Hossien Shahdadi[3], Majid Reza Akbarizadeh[4], Elham Shahraki Moghadam[5]

[1]Student Research Committee, Department of Medical Surgical Nursing, School of Nursing and Midwifery, Zabol University of Medical Sciences, Zabol, Iran
[2]Associate Professor of Nursing, Department of Medical Surgical Nursing, School of Nursing and Midwifery, Zabol University of Medical Sciences, Zabol, Iran
[3]Assistant Professor of Nursing, Department of Medical Surgical Nursing, School of Nursing and Midwifery, Zabol University of Medical Sciences, Zabol, Iran
[4]Associate Professor of Pediatric Infectious Disease, Department of Pediatrics, School of Medicine, Amir al Momenin Hospital, Zabol University of Medical Sciences, Zabol, Iran
[5]Instructor of Nursing, Department of Medical Surgical Nursing, School of Nursing and Midwifery, Zabol University of Medical Sciences, Zabol, Iran

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***Corresponding author:**
Department of Medical Surgical Nursing, School of Nursing and Midwifery, Zabol University of Medical Sciences, Zabol, Iran.
Email: mahin.naderifar@gmail.com

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Abstract

Background: Escape rooms are a new way to teach that makes students more interested and involved. Using escape rooms in the classroom helps students understand and remember what they have learned.

Objectives: The goal of this research is to find out how an escape room-based cardiopulmonary resuscitation (CPR) test affects the self-efficacy of nursing students in their second and third semesters.

Methods: A total of 36 second and third-semester undergraduate nursing students participated in this experimental study, which used a pre-test-post-test design with a control group. Participants were randomly assigned to one of two groups: intervention (18 individuals) or control (18 individuals). Data collection tools included a demographic questionnaire, a CPR checklist, and Turner's CPR Self-Efficacy Scale, which participants completed both before and after the intervention. Participants in the intervention group split up into groups of three, each of which had a maximum of 40 minutes to unlock five locked boxes and leave the room. Descriptive statistics, the Chi-square test, independent and paired t-tests, and other statistical analyses were performed using SPSS version 16 software.

Results: Prior to the intervention, the researchers found no significant difference in the self-efficacy perception ratings of students in the escape room group (117.94±25.68) and the mannequin group (118.20±39.76) ($P > 0.05$). The independent t-test, however, revealed a statistically significant difference between the two groups' mean post-intervention self-efficacy scores ($P < 0.001$). The escape room group's mean increase over the mannequin group was 18.56, yielding an effect size of 0.6. This suggests that students who took the escape room test saw a modest increase in their judgment of their own effectiveness.

Conclusion: According to the study's results, the escape room approach may be just as successful in raising perceptions of CPR self-efficacy as the conventional mannequin-based evaluation. In the end, active learning techniques might develop into a very successful teaching strategy in nursing school. We advise carrying out more research to examine the effects of escape room design principles, learning goals, and student profiles in order to guarantee the efficacy of this approach.

Keywords: Cardiopulmonary Resuscitation; Escape Room; Nursing Students; Self-Efficacy

Background

One of the most serious medical crises is cardiac arrest (1), which continues to be one of the top causes of mortality and affects many individuals worldwide each year (2) despite the advancements in medical technology. For instance, between 350,000 and 700,000

individuals in the European Union and 400,000 people in the US pass away from cardiac arrest outside of hospitals each year (3). The Ministry of Health reports that 300,000 individuals die from cardiac arrest each year (4). Cardiopulmonary resuscitation (CPR) is the first treatment of an individual who has had a cardiopulmonary arrest (5). Cardiopulmonary resuscitation is a life-saving technique that keeps the patient breathing and blood flowing so that the body's important systems can get the bare minimum of oxygen (6). Nurses are crucial to CPR (7) and must possess the necessary knowledge and abilities (8) since they are often the first to reach the patient's bedside during cardiac arrest (2). Nonetheless, many medical professionals are unable to provide effective CPR in authentic clinical environments (9). Less than 10% of nurses in the cardiac critical care unit are adequately trained to do cardiopulmonary resuscitation, according to the findings of an Iranian research (10). Research shows that nursing students' scientific and practical understanding of resuscitation is insufficient, despite the fact that resuscitation information and skills are taught practically from the start of nursing school (5). Three elements are often needed to save a patient from cardiac arrest: medical science, hands-on training, and proper execution. This highlights the significance of education in patient survival (11). CPR instruction is thus essential for nursing students (12). According to the conventional approach, students learn how to conduct CPR by practicing on mannequins after the teacher demonstrates the technique (13). It is advantageous to employ mannequins to educate nursing students because they enhance their communication and caregiving abilities (14), as well as solve the issues with providing high-quality CPR (15). New teaching methods have gained popularity recently to help nursing students become more proficient (8). These tactics include educational escape rooms, a brand-new group-based learning approach (16) that helps students retain and apply what they have learned in class.Escape rooms are interactive environments in which participants, frequently in small groups, must solve puzzles within a designated time frame in order to "escape" the room (17). This configuration induces a sense of urgency and exhilaration, which can substantially increase learners' motivation and engagement (18). Furthermore, escape chambers present students with the opportunity to exercise their critical and creative thinking skills. They are required to alter strategies in response to the changing context of the game, make decisions under duress, and analyze information (19). Moreover, due to their enjoyable nature, escape rooms motivate students to engage in studying (20). Escape rooms need parties to collaborate in order to escape by adhering to a narrative and resolving a sequence of problems.A major aspect in CPR instruction is self-efficacy (21). Self-efficacy is a fundamental concept in Bandura's social cognitive theory and influences how caregivers prepare to organize and execute appropriate actions during resuscitation (22). Nurses must have confidence in their capacity to provide superior care to cardiac patients (23). Roh said that nurses who have knowledge and awareness but lack self-confidence and assurance in their skills encounter difficulties in executing CPR. Research suggests that persons with sufficient knowledge and abilities in CPR may yet refrain from doing it due to poor self-efficacy; hence, educators should address this concern via effective pedagogical strategies (24). Nurses often arrive first at the patient's bedside during cardiopulmonary resuscitation and are crucial to the efficacy of resuscitation operations. Conventional pedagogical approaches often overlook the significance of elevated self-efficacy perceptions among nurses, an essential element for the effectiveness of CPR. Consequently, it is essential to investigate innovative teaching approaches, such as escape rooms, that actively involve pupils. This transition to experiential learning corresponds with the need for nurses to be well equipped for practical situations.

Objectives

The objective of the current study conducted at Zabol University of Medical Sciences was to examine the influence of escape room-based CPR assessment on the self-efficacy of nursing students in their second and third semesters.

Methods

Study Design: In order to achieve the study objectives, the researchers implemented an experimental pre-/post-test research design with a control group at the Nursing and Midwifery School of Zabol University of Medical Sciences from April to May 2024.

Participants: The incorporation of students who had not previously participated in an educational escape room or had not taken a separate CPR course outside the curriculum was the basis for evaluating the second- and third-semester undergraduate nursing students recruited in this study. The study excluded students who were not

enrolled in the practicum course, did not attend the sessions, or had incomplete grades.

Sampling: The statistical population comprised 40 fifth-semester undergraduate students. A prior study by Mohammadi et al. (25) indicated that the Mean score and Standard Deviation (SD) for the intervention (flipped classroom method) and control (face-to-face education) groups were 94.48±8.83 and 86.37 ± 5.76, respectively. It was estimated that a minimum sample size of 18 nursing students per group, with a confidence interval (CI) of 95% and a test power of 90%, was required for each group.

$$n = \frac{\left(z_{1-\alpha/2} + z_{1-\beta}\right)^2 (\delta_1^2 + \delta_2^2)}{(\mu_1 - \mu_2)^2} =$$

$$\frac{(1.96 + 1.28)^2 (77.96 + 33.17)}{(94.48 - 86.37)^2} = 18$$

Intervention: The researchers conducted an orientation session for second and third-semester undergraduate nursing students to elucidate the significance of innovative teaching approaches, such as escape rooms, and their impact on learning outcomes. Subsequently, the researchers performed six-hour CPR training sessions for each semester group. Each course included four hours of lecture and two hours of mannequin exercise. The teaching material was based on the 2020 AHA CPR recommendations and underwent evaluation by three faculty members prior to implementation (26). All lessons were overseen by an educator specializing in critical care nursing. During the previous session, the researchers administered a pre-test to evaluate each student's CPR proficiency by identifying faults in their performance using a checklist. Three weeks later, they administered the self-efficacy questionnaire. Subsequently, pupils were randomly allocated to two groups by a simple random selection technique employing cards.

Course design: In order to construct this procedure, a problem-solving pattern from Maastricht University was applied. In the initial phase, a conference was conducted among three faculty members to comprehend the issue and discuss the escape room, including what needed to be communicated and clarifying points and misunderstandings about the clinical assessment. In the subsequent phase, the group members reached a consensus on the questions that needed to be addressed to elucidate the problem. The third phase featured brainstorming, when group members offered their opinions on the topic. In the fourth stage, they evaluated the data and categorized the material into three distinct groups: indicators of cardiac arrest, CPR procedures, and the use of emergency equipment. In the fifth step, they defined specific learning goals for the escape room:

Identify the signs and symptoms of the cardiac arrest.

- Demonstrate proper technique for chest compressions.
- Explain the importance of ventilation during CPR, including the ratio of compressions to breaths, and identify tracheal tube equipment.
- Explain the steps involved in using an electroshock device, including pad placement and shock delivery.
- Execute a full sequence of ACLS protocols, including rhythm analysis.
- Identify common medications used during advanced CPR, including epinephrine, vasopressin, and amiodarone.
- Explain the importance of monitoring and checking vital signs.

In the sixth step, the escape room was designed using the principles of design for simulation games noted by Koivisto et al. (2018). Using realistic and authentic patient scenarios to apply nursing knowledge in context, integrating learning objectives with game mechanics to enable students to apply clinical reasoning processes, allowing for experimentation within the game to give students alternative choices, actions, and paths (e.g., different rhythms for analysis or drug injection in the sequence of ACLS protocols), and using an online game to provide authentic graphics are some examples of these design principles (27). They considered three roles (leader, navigator, clue finder) to ensure that all team members contributed. The leader was responsible for guiding the team and making decisions; the navigator focused on keeping track of game's progress and managing time; and the clue finder searched for hints and solutions to the challenges presented in the escape room.

Flow of Escape Room

Pre-Brief: Right before the escape room game began, all students participated in a 10-minute face-to-face pre-brief session. A list of necessary materials, duties and regulations, and a rough concept of an escape room were all included in the pre-brief. After that, the students were instructed to divide into groups of three and assign each other roles according to their own choices. The participants were given an envelope with the first clue and instructed not to open it until they were inside the operating room.

Escape Room Activity: The escape room activity theme was based on Resuscitation Challenge. Students had to use their knowledge and skills in CPR to solve puzzles and riddles related to the topic, ultimately unlocking each box. They had only 40 minutes to unlock the five locked boxes and escape the room. After resuscitating the patient and opening all five crates, they were able to exit the room. A cardiopulmonary resuscitation protocol was employed by one of the researchers to evaluate the performance of each student. Each box contained resuscitation apparatus and a hint to locate the three-digit code for the subsequent box. One of the researchers was present inside the escape room to guide the students as a facilitator when they needed help solving the puzzles.

After completing escape room, participants received feedback on their performance in a 15-minute session using the PEARLS model, which consists of five stages: Setting the Scene, where a researcher creates a safe learning environment; Reactions, where a researcher reviews students' initial feelings; Description, where evaluators determine the reasons for poor performance, including struggles with equipment or uncertainty about procedures; Analysis, where researchers ask learners to identify successful interventions and those they would change, while providing feedback to address performance gaps; and Application/Summary, where the instructor summarizes lessons learned and encourages learners to identify future applications. Finally, participants completed a self-efficacy questionnaire.

Puzzles: The first puzzle involved monitoring the patient. Students had to find and connect the pieces of the puzzle, which were taped to various surfaces, including the emergency trolley, bed, and electrocardiogram device. The first box's code corresponds to the number of pulses identified in the nursing report, as indicated by the completed puzzle. The second puzzle focused on identifying tracheal tube equipment. Students located the equipment on the table, each labeled with a specific color code, and used the guide sheet from the previous box to find the correct code for the third box.

Puzzle three related to chest compressions. Students deciphered a code on the patient's wristband, which led to the question, "What is the minimum chest compression depth in mm?" This was the code for the fourth box.

The next puzzle was a crossword with questions about CPR, specifically signs and symptoms of cardiac arrest. The hidden code in the puzzle was the code for the second box.

The final conundrum concentrated on the most frequently prescribed medications for cardiopulmonary resuscitation. Students were directed to an online game where they were able to locate the code for the final capsule by scanning a QR code. The items in each compartment were arranged in the following order: Electric Shock Paddle, Patient's Electrocardiogram, Tracheal Tube, Chest Lead, and Epinephrine. The escape room follows a linear structure, but the scenario varied based on the interpretation of ECG readings. There were two types of ECG patterns that students encountered: Ventricular Tachycardia (VTAC) and Asystole.

In the third box, students found three distinct ECG strips arranged in the order of each phase of CPR. The first ECG strip represented the initial rhythm before CPR was started. The second ECG strip appeared after the first shock was delivered. The third ECG strip corresponded to the rhythm after further CPR efforts. Students needed to determine the appropriate CPR response based on the identified rhythm. Throughout the game, alternative choices were integrated into the CPR phases (Table 1).

Scenario: As medical students, you and your team are participating in a training exercise at a local hospital. Suddenly, you receive an emergency call from the cardiac care unit. A patient who was previously stable has experienced cardiac arrest. Your team has a mere ten minutes to reach the unit and revive the patient before it is too late. Upon your arrival at the unit, you discover that the door is sealed from the inside. In order to gain entry, you must solve a sequence of puzzles and mysteries. The clues are scattered throughout the room, and you must work together to find and decipher them. Once you've solved the puzzles, you can use the resuscitation equipment in those boxes to save the patient.

Room Set Up: In the skills labs, the researchers designed the escape room to resemble a room in one of the hospital wards, complete with a patient bed, monitor, glove box, etc. In total, the researchers used one escape room to assess students' CPR skills, equipping it with three simulated patients (mannequins). Other supplies in the room include a blood pressure cuff and a laryngoscope blade with a handle.

Control group: CPR test for the mannequin group was conducted individually by the same person, with specific learning goals, within a set time limit and environment. The researcher assessed each student's

performance in the skills labs, where they performed CPR on the mannequin using the CPR checklist. Then, the researchers distributed the self-efficacy questionnaire immediately after the intervention (Table 2).

Instrument

The data collecting instrument consisted of three parts: a demographic information form, a CPR checklist, and a CPR-specific self-efficacy scale devised by Turner and colleagues, which had 17 items. This scale used a 10-point visual analog scale, a self-report scale, to answer the questions. The scale ranged from 1 (the lowest) to 10 (the highest reported score). The total score ranged from 1 to 170, with scores categorized as follows: 1-56, insufficient self-efficacy; 57-112, moderately sufficient; and 113-170, sufficient. The tool's validity and reliability were previously investigated in a study by Heydarzadeh et al., which reported a Cronbach's alpha of 0.83. The demographic information form for nursing students, which was utilized to gather information such as age, gender, the most recent educational average, semester, residence status, and interest in nursing, was scientifically and content-validated by three faculty members of Zabol University of Medical Sciences. Additionally, the questionnaires' reliability was evaluated following a pilot study consisting of 10 nursing students that was administered randomly (r = 0.85). The American Heart Association's resuscitation principles were adhered to by the advanced resuscitation skills checklists, which consist of four sections: tracheal intubation (14 items), cardiac massage and artificial respiration (20 items), defibrillator use (15 items), and resuscitation management (4 items). Each accurate response was worth one point, while the incorrect response was worth zero points. The checklist's content validity coefficient was 0.89, and its Pearson correlation coefficient ranged from 0.79 to 0.91, as per Adib and Lotfi's study (28). It is important to mention that the Cronbach alpha coefficient formula ($\alpha = 0.74–0.85$) was employed to assess the checklist's reliability.

Data Analysis: All statistical analyses were performed using SPSS statistical software (version 16). Kolmogorov-Smirnov test was used to evaluate the normality of variables. Based on this, the assumption of normality was confirmed for all variables. Descriptive statistics, i.e., mean ± standard deviation, percentage, and frequency, were used to describe the characteristics of the participants. Chi-square and independent t-test were used to compare qualitative and quantitative demographic data between intervention groups. Also, the paired t-test was used to examine the effect of self-efficacy perception in both groups.

Results

Initially, 36 eligible participants were chosen among 40 undergraduate nursing students utilizing the convenience sample method and inclusion criteria.

In the post-test stage, all students (100 percent response rate) completed the questionnaires and participated in the research. Participants in the escape room group had a mean age of 19.94±1.98 years, compared to 20.89±2.05 years in the mannequin group ($P = 0.05$). The chi-square test findings showed no significant differences between the two groups in terms of gender, residency status, or interest in nursing, showing homogeneity. Furthermore, there was no statistically significant difference in age between the study groups ($P > 0.05$) (Table 3).

The partial eta squared value was then computed to see how much variation in the dependent variable (mean self-efficacy perception scores) was explained by the independent variable. It has a medium to high effect size, suggesting that the independent variable has a practically substantial impact on the dependent variable. A research with this sample size is expected to have enough statistical power and a low margin of error to detect an association, hence the study was classified as significant. For further analysis, the results of the independent t-test showed that there was no significant difference among the scores of CPR-specific self-efficacy perception of students receiving the mannequin approaches (118.39±20.76), and the escape room group (117.94±25.68) before the intervention ($P > 0.05$). After the interventions, the escape room method increased students' CPR-specific self-efficacy perception scores (18.56±15.61) more than the mannequin approach (0.61±17.32). The independent t-test was performed based on the difference among the mean scores of the pre-test and post-test stages in intervention groups, which showed a statistically significant difference ($P = 0.003$). The results of the paired t-test also showed that there was no significant difference between the mean pre-test and post-test scores in the mannequin group ($P = 0.88$), while the escape room group showed significantly more positive changes in their self-efficacy ($P < 0.001$; $t(35) = 5.043$) (Table 4).

CPR errors were measured by counting the number of items on a standardized CPR checklist that students failed to complete properly, with each missing item representing one error.

The Wilcoxon signed-rank test revealed no significant change in the mean number of errors before and after the intervention in the mannequin group (P = 0.14). The escape room group made significantly fewer errors (P < 0.001) (Table 5).

The independent t-test revealed no statistically significant difference in mean scores before the intervention between the two groups in the variable perceived self-efficacy. Furthermore, the mean scores following the intervention in the category of perceived self-efficacy differed significantly between the two groups.

The results of Wilcoxon signed-rank test indicated that there was no significant difference between the mean number of mistakes before and after the intervention in the mannequin group (P < 0.149). In contrast, the escape room group showed a significant reduction in their number of mistakes (P < 0.001).

Discussion

This study aimed to determine the effect of escape room-based assessment on the self-efficacy perceptions of nursing students. Both groups had adequate self-efficacy perception ratings before to the evaluation, and there was no significant difference between the two groups prior to the intervention. The participants' self-efficacy perception score improved after training with a mannequin in the assessment group, but it was not statistically significant when compared to before training. In the assessment group with the escape room, the study participants' self-efficacy perception score improved following the training, which was statistically significant. Moreover, the researchers observed differences between two groups after training. The escape room group made significantly fewer mistakes during CPR.

The researchers were unable to discover any studies that investigated the influence of escape room-based evaluation on self-efficacy perceptions of CPR; so, the researchers analyzed the study's results individually with the escape room and mannequin approaches. The findings supported prior study, emphasizing the significance of self-efficacy in nursing skill training, particularly CPR. This shows that nurses should be confident in their abilities to care for cardiac patients (9). Previous research shown that self-efficacy decreases anxiety and improves nurses' ability to conduct cardiopulmonary resuscitation (8). Nursing students who practice proper cardiac massage have increased self-efficacy (29). Furthermore, Roh et al. (2014) discovered that even those with adequate knowledge and competence in CPR may fail to do it if they have poor self-efficacy. To counter this, educators must improve self-efficacy using suitable instructional methods (24). One of these methods is mannequin-based simulation. Based on Roh et al. (2011), mannequin-based simulation in nursing education increases participants' self-efficacy perception, which in turn leads to better quality CPR delivery (30).

Unlike our present investigation, simulation using a mannequin did not boost self-efficacy perceptions, which was consistent with Monjamed et al.'s findings. This research looked at the effects of two CPR teaching modalities, video and mannequin, on nursing students' knowledge and performance. Most nursing students in the mannequin and video approaches had the greatest degree of CPR knowledge, with no difference between the two teaching modalities (1). Roh's study recommended that future research explore new and diverse simulation methods, which can be used in combination with each other (30). For example, one method involves incorporating active learning methods (16).

Active learning includes a wide range of learning activities, including the flipped classroom, team-based learning, collaborative learning, games, role-playing, and so on (31, 32). Using these strategies may have a variety of good outcomes, including increased self-efficacy beliefs, improved student motivation, and increased performance and interest in relevant academic and professional pursuits (33). Jeong et al. (2019) discovered that active learning strategies enhance students' emotions and self-efficacy views. Furthermore, the research found that higher self-efficacy ratings are associated with better performance and greater satisfaction. Students with lower levels of self-efficacy, on the other hand, are more likely to dread failure (34).Th us, Andres et al. (2020) stated that active learning strategies can lead to better academic outcomes, such as higher grades and an increased likelihood of continuing education, by promoting academic self-efficacy and reducing task avoidance behaviors (35).

One of the active learning methods is using educational escape rooms. Previous studies have used escape rooms in various health science disciplines, including nursing, and referred to them as an innovative learning method or an assessment method (36). In one study, Adams et al. (2018) reported that escape room participants found it remarkably interesting and entertaining, and they suggested using game-based learning as a teaching strategy for nurses (37).

According to Molina Torres et al. (2022), escape room participants believe that this activity improves their critical thinking because they had to think about each puzzle and discuss it with one another, which improves their decision-making process, helps them remember concepts, and helps them prepare for the theory exam. In other words, this game-based strategy enhances the teaching-learning process while helping nursing students to acquire important information and build nursing skills (36). According to Bandura's self-efficacy theory, more flexible ways of learning should be adopted, resulting in increased educational engagement (38). Escape rooms are an example of a flexible and inventive strategy. Furthermore, the present study's findings revealed a substantial statistical difference in students' academic self-efficacy between the escape room group and the mannequin-based assessment technique (39). These findings suggest that the escape room format's adaptability and interactivity may be more helpful in boosting students' confidence in their academic talents and learning outcomes. However, the findings should be regarded with care owing to a number of limitations, including the unique location, small sample size, and use of convenience sampling, all of which may have an impact on the results' generalizability. To improve external validity, further study should be undertaken. Although educational escape rooms are extremely effective learning activities that may dramatically boost students' knowledge levels and satisfaction (40), Hood et al. (2021) said that although active learning improves student outcomes in STEM programs, it can also create anxiety. Students who experience social anxiety have poorer final marks (41). Among the limitations of escape rooms, based on the study by Eukel et al. (2020), are the number of rooms available, the cost of locks and escape room equipment, facilitator training, and the time required for setup, implementation, and review after completing the escape room (42).

Although setting up a physical escape room can be time-consuming and costly, virtual escape rooms offer a solution. Using Google Forms, you can create a virtual escape room without incurring any costs, although it may take some time to learn how to use the program (33).

Also, Karageorgiou et al. (2019) stated that even with guidance, not all students can complete the escape room. They cited insufficient time and motivation for not completing the escape room (43).

According to research, a few students dislike escape rooms or feel uncomfortable partaking in the experience, but usually, the feedback is good (33). Escape rooms allow students to participate in real-world circumstances in which they must use their knowledge. Collaborative problem solving in a time-limited situation is consistent with active learning theories. It improves critical thinking abilities in nursing practice (44).

Conclusion

According to the study's results, the escape room approach may be more helpful than typical mannequin-based assessments in improving CPR self-efficacy perceptions. Regardless of the findings of the statistical analysis, the mannequin evaluation provides certain benefits for improving student learning. To successfully use an escape room in nursing education settings, it is critical to first determine particular learning goals that are relevant to the curriculum. Gathering the appropriate resources and educating faculty in facilitation approaches will improve the immersive experience. Additionally, including the escape room into the curriculum via debriefing sessions will assist students in connecting principles taught to real-world nursing practice. Ultimately, active learning strategies should be considered a potential teaching method in nursing education. To ensure the effectiveness of escape rooms, it is essential to carefully evaluate the escape room design principles, learning objectives, and student characteristics.

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Table 1. Content and Objectives of the Escape Room

Box	Content	Educational Objectives	Puzzle to Unlock the Box	Tasks
1	Chest Lead	Checking Vital Signs	Pieces of a puzzle were hidden inside the room. Students had to find and connect the pieces before solving the puzzle. It was also written on the puzzle that the code for the first box equals the number of pulses, which they could find using the nursing report.	Monitoring the patient
2	Tracheal Tube	Identifying Tracheal Tube Equipment	Students were tasked with detecting the tracheal tube equipment on the table, each labeled with a specific color code. Using the guide sheet from the previous box, they had to find the correct code for the third box.	Inserting a Tracheal Tube
3	Patient's Electrocardiogram (ECG)	Performing Chest Compressions Correctly	Deciphering a piece of code: Students had to decipher a piece of code on the patient's wristband. By solving it, they would come across a question that was the code for the fourth box.	ECG Interpretation
4	Electric Shock Paddle	Familiarity with the Basic Principles of Resuscitation and Diagnostic Tests	Crossword: Students had to solve a crossword puzzle with questions related to CPR, and in the end, the hidden code in the table was the code for the second box.	Using defibrillator
5	Epinephrine	Familiarity with Resuscitation Equipment and Pharmaceutical Calculations	Online Game: Students had to scan a QR code that redirected them to an online game, and by solving it, they could find the code for the last box.	Drug Injection

Table 2. PEARLS Model for Providing Feedback to Students

Stage	Activity
Setting the scene	One of the researchers will hold a feedback session for students, aiming to create a safe environment for learning.
Reactions	One of the researchers reviewed the students' initial reactions and feelings.
Description	The evaluators had to determine if the reason for the student's poor performance was apparent or not. Was the learner struggling with equipment usage or unsure about the correct procedure?
Analysis	In this step, the researchers asked the learners to identify the interventions they did well and the interventions they would change if they could redo their performance. The evaluator provided information to eliminate the student's performance gaps.
Application/summary	The instructor presented a summary of the lessons learned and asked learners to identify points they could use in the future.

Table 3. Comparison of Demographic Characteristics between the Two Intervention Groups

Variables	The mannequin group[a] (mean (SD))	The escape room group[b] (mean (SD))	P[c]
Age	20.89(2.05)	19.94(1.98)	0.17
GPA	16.82(1.49)	16.94(1.44)	0.82
	Number (Percentage)	Number (Percentage)	
Gender			0.09
Female	6(33.30%)	11(61.10%)	
Male	12(66.70%)	7(38.90%)	
Resident status			0.45
Dormitory	14(77.80%)	12(66.70%)	
Home	4(22.20%)	6(33.30%)	
Semester			1.00
Two	8(44.40%)	10(55.60%)	
Three	10(55.60%)	8(44.40%)	
Interesting to the nursing filed			0.29
Yes	10(55.60%)	13(72.20%)	
No	8(44.40%)	5(27.80%)	

a) The mannequin-based methods group; b) The escape room methods group; c) The independent t-test was used to compare the groups; statistically significant at P-values<0.05; d) Chi-square test was used to assess the difference in the distribution of a categorical variable between two independent groups.
SD: Standard deviation

Table 4. Comparison of the Mean Score of the perceived Self-Efficacy Score in the Intervention Groups

Group	Before intervention (mean (SD))	After intervention (mean (SD))	Mean Difference (95% CI)	Paired t-test (P-value)
Mannequin group	118.39(20.76)	119.00(26.306)	0.61 (-9.23, 8.00)	0.88
Escape room group	117.94(25.68)	136.50(24.71)	18.56 (10.79, 26.32)	< 0.001

SD: Standard deviation; CI: Confidence interval

Table 5. Comparison of mean number of mistakes in the two control and intervention groups

Mistakes	Before intervention (mean (SD))	After intervention (mean (SD))	P
The mannequin group[a]	5.12(4.95)	4.87(4.99)	0.140
The escape room group[b]	5.29(4.76)	3.83(4.25)	< 0.001

SD: Standard deviation