Title: Digital Escape Room Game for Hypovolemic Shock Management: A Mixed-Methods Study in Nursing Education

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Study Protocol:

Methods

Study design

This study employed an explanatory sequential mixed-methods design. A randomized controlled trial design was used in the quantitative phase. The experimental group participated in an online escape room intervention, while the control group received traditional lecture-based instruction. Quantitative data were collected to evaluate the effect of the intervention on students' knowlegde level and satisfaction.

Following the quantitative phase, a purposive sample of students from the experimental group was invited to participate in focus group interviews. The qualitative phase was conducted to explore students' perceptions and experiences in greater depth, providing contextual insights into the mechanisms underlying the quantitative results. Integrating the two phases allowed for a more comprehensive understanding of the educational impact of the online escape room intervention, combining measurable outcomes with rich narrative accounts.

Setting and participants

The study was conducted between June and July 2025 with third-year nursing students enrolled at a foundation university in Ankara, Türkiye. Students were invited to participate through an in-class announcement, and the inclusion criterion was being a third-year nursing student who provided informed consent.

Power analysis was performed using G*Power 3.1 (F tests, repeated measures ANOVA—between-group effect). Based on two groups and three measurement points, a

repeated measures correlation of 0.50, an effect size of f=0.35, a two-way α=0.05, and a power of 1−β=0.80, the required total sample size was calculated as N=46 (23 participants in each group). Considering possible attrition, a total sample size of 30 participants was planned for each group. Accordingly, 58 volunteer students were recruited for the quantitative phase and randomly assigned to either the intervention or control groups. For the qualitative phase, 12 students were purposively selected from among those who had participated in the quantitative phase. In addition, nurse educators with at least five years of experience in teaching and mentoring students were included as participants. Data collection for the qualitative phase was carried out through focus group interviews and continued until no new themes emerged, indicating thematic saturation.

Randomisation and Blinding

Eligible participants were randomly assigned to either the experimental group, which received the digital escape room game intervention, or the control group, which received traditional classroom-based education, in a 1:1 allocation ratio. Randomisation was performed using an online random sequence generator (Research Randomizer, https://www.randomizer.org/) by an independent statistician who was not involved in participant recruitment, intervention delivery, or outcome assessment.

Given the nature of the interventions, blinding of participants and facilitators was not feasible. However, to minimise performance and detection bias, outcome assessors and data analysts remained blinded to group allocation throughout the study. All data were coded anonymously, and statistical analyses were conducted using coded identifiers (Group A/Group B) until the final interpretation phase.

Pre-application of the study

A preliminary application was undertaken to assess the clarity, feasibility, and functionality of both the data collection instruments and the digital escape room game. This

stage was conducted with 10 fourth-year nursing students enrolled in the 2024–2025 academic year. Participants were asked to complete the data collection forms, engage with the escape room game, and provide structured feedback regarding the comprehensibility of the forms, the usability of the game design, and the alignment of tasks with the intended learning outcomes.

Based on the feedback obtained, minor revisions were made to enhance the precision of the data collection tools and to optimize the flow and instructional components of the game. Following these adjustments, both the instruments and the game were finalized for the main study. To maintain methodological rigor and avoid potential bias, students who participated in the pre-application were excluded from the final sample.

Implementation phase of the study

All students who agreed to participate first completed the Sociodemographic Information Form, followed by the Hypovolemic Shock Information Form as a pretest. After the pretest, all participants received a two-hour traditional lecture on hypovolemic shock and nursing management. The lecture covered the following topics: definition, etiology and risk factors, pathophysiology, clinical findings and diagnosis, medical treatment approaches, nursing care and processes, nursing diagnoses and interventions, patient education, and psychosocial support. Students were then randomly assigned to either the intervention or control group, ensuring comparable mean pretest knowledge scores.

Control Group (n = 28): In addition to the two-hour theoretical training, no further intervention was provided. Immediately after the lecture and again one month later, students completed the Hypovolemic Shock Information Form as a posttest. After completion of the study, control group participants were also given the opportunity to experience the digital escape room game.

Intervention Group (n = 27): Following the pretest and theoretical training, students played a digital escape room game on hypovolemic shock and nursing management developed

by the researchers using the *Genially* platform. The design and procedures of the game are detailed in the "Experimental procedure" section. Immediately after the intervention and again one month later, students completed the Hypovolemic Shock Information Form as a posttest. In addition, the GAMEX (Game Experience) Scale was administered, and a subset of students participated in a focus group interview.

Experimental procedure

This study was conducted with third-year undergraduate nursing students to evaluate knowledge and management of hypovolemic shock. It comprised two stages: (1) development and implementation of the HYPSEM ERG, and (2) testing the game and assessing outcomes.

Stage 1: The HYPSEM (HYPovolemic Shock EMergencies) ERG was developed, introduced to students, and made available for one week.

Stage 2: Upon completion, students' knowledge and satisfaction were evaluated.

HYPSEM game procedure

HYPSEM is a web-based digital escape room addressing hypovolemic shock (HVS). It was designed to examine whether escape rooms enhance motivation to learn about HVS. Development on the *Genially* platform enabled the creation of interactive click-and-point rooms, fostering engagement. Hosting the game online ensured universal access without spatial or temporal constraints.

Implementation proceeded as follows:

- Students first received a face-to-face briefing in which the designer introduced escape rooms, explained the *Genially* platform, and outlined the collaborative structure of the game.
- They were then given one week to play individually at their convenience.

- The designer shared contact information to provide technical support. Students could request unlimited hints and were reassured that feedback would be available even without prior experience.
- After successfully completing the final test and exiting the escape room, students filled out a post-test questionnaire.

Escape room design

HYPSEM simulates a hospital room scenario involving a patient with hypovolemic shock, requiring students to access essential information from the patient's file to prevent adverse outcomes. The game can be accessed via *Genially* (https://view.genially.com/685bc3f26dbc4e0ec352beb0/interactive-content-hastaneden-kacis-oyunu).

Students had 15-20 minutes to solve six puzzles. Content aligned with prior lectures, practice sessions, and case studies; no new information was introduced during gameplay to facilitate smooth progression. Access was provided via QR code. The game opened with a clinical narrative, followed by rules, instructions, and symbol explanations.

The puzzles included multiple-choice, true/false, sequencing, and clinical reasoning tasks related to shock type, stage, management, and nursing interventions. Clues were drawn from patient files, physical examination findings, laboratory results, and vital signs. Incorrect responses triggered warning signals as feedback. A countdown timer imposed time constraints, and hints were embedded in items such as the patient file, behind a door, an electrocardiograph, a medication bag, and above a cupboard. Successful management of the patient and hospital exit designated students as "heroes." Students could replay the game without restriction during the one-week study period.

Data collection

Data were collected face-to-face and via Google Forms between June 2 and July 20, 2025. In this study, multiple instruments were employed to assess students' knowledge of shock management, their satisfaction with the game, and their perceptions of the digital escape room.

Quantitative data

Sociodemographic Information Form

Sociodemographic data, including participants' age, gender, and prior experiences, were collected using a form developed by the researchers based on the literature (Bonaduce, 2024; Şat et al., 2025).

Hypovolemic Shock Information Form

A 20-item true-false test was administered to measure students' theoretical knowledge of hypovolemic shock. The form was reviewed by seven field experts to establish content validity and was administered both as a pretest and a posttest.

GAMEX (Game Experience) Scale

Students' experiences with the digital escape room were evaluated using the 27-item, 5-point Likert-type GAMEX scale (Eppman et al., 2018). The instrument comprises six subscales: enjoyment, absorption, creative thinking, involvement, absence of negative effects, and dominance. The Turkish adaptation was validated and found reliable by Arıkan Dönmez et al. (2024). Scale scores range from 27 to 135, with higher scores indicating a more positive gaming experience. Cronbach's alpha was 0.93 for the total scale, and subscale alphas ranged from 0.67 to 0.929.

Qualitative data

Focus group discussions with students and facilitators were organized within one week after the completion of the HYPSEM game. The sessions were held via the Zoom video conferencing platform and followed a semi-structured interview form. Three female researchers with expertise in qualitative research served as moderators to ensure both consistency and depth

of the discussions. The interview form consisted of four open-ended questions addressing participants' expectations prior to the game and whether these were fulfilled, the emotions they experienced during the activity, the game's contribution to their learning (e.g., knowledge, practical skills, decision-making), and their opinions on the broader use of digital escape room games in nursing education. The discussions explored not only students' experiences and perceptions of the usefulness of the HYPSEM game, but also their suggestions for areas of improvement. Each focus group included three to five participants and lasted between 45 and 80 minutes. All sessions were audio-recorded and subsequently transcribed verbatim.

Statistical Analysis Plan (SAP):

Quantitative data analyses were conducted using IBM SPSS Statistics version 25. Descriptive statistics (mean, standard deviation, minimum, and maximum) were calculated for all study variables. The internal consistency of the GAMEX scale and its subdimensions was assessed using Cronbach's α coefficients.

To evaluate baseline equivalence between groups, independent samples *t*-tests were performed. The effectiveness of the intervention over time was examined using a repeated-measures analysis of variance (ANOVA) with one within-subjects factor (time: pre-test, post-test 1, post-test 2) and one between-subjects factor (group: GAMEX vs. control). Mauchly's test of sphericity was applied to verify the assumption of sphericity, and where violations occurred, the Greenhouse–Geisser correction was used. Effect sizes for ANOVA results were reported as partial η^2.

In addition, Bonferroni-adjusted pairwise comparisons were conducted to explore differences across the three time points within each group. Independent samples *t*-tests were also carried out at each measurement point to assess between-group differences. For these comparisons, Cohen's *d* values were calculated to estimate the magnitude of differences (0.2 = small, 0.5 = medium, 0.8 = large). Statistical significance was set at $p < .05$ for all analyses.

Qualitative data were derived from audio-recorded focus group discussions, which were transcribed verbatim and analyzed thematically following Braun and Clarke's (2006) six-phase framework: (1) familiarization with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report. Coding was independently conducted by two researchers using MAXQDA Analytics Pro 2022 software. Codes were then grouped into subthemes based on similarities, and consensus was reached through regular discussions and deliberations. A third researcher verified themes, and the entire research team engaged in reflective discussions to enhance interpretive rigor. To ensure trustworthiness, Lincoln and Guba's (1985) criteria were applied: credibility through peer debriefing and researcher triangulation; dependability through independent coding; confirmability via detailed documentation and audit trails; and transferability through thick description of the study context and the inclusion of direct participant quotations. Data collection and analysis were concluded once thematic saturation was reached.

Mixed methods analysis/Data triangulation /Data integration

After separately analyzing quantitative and qualitative data, integration was carried out to achieve a comprehensive understanding of the research problem. Mixed methods integration enables the examination of convergence and complementarity between different forms of evidence, thereby increasing the validity and robustness of the study (Creswell & Plano Clark, 2018; Fetters et al., 2013). Data triangulation was employed to mitigate the limitations of relying solely on a single method and to ensure that both measurable outcomes and contextual insights were considered in addressing the research objectives. In this study, integration was pursued not to duplicate findings but to provide methodological rigor, support the credibility of interpretations, and generate a more holistic view of the educational impact of the digital escape room intervention (Guetterman et al., 2015; McCrudden et al., 2021).